SCHEME & SYLLABUS

M.Sc. (Hons.) Physics

(PG Programme as per NEP 2020)

Department of Physical Sciences

University Institute of Sciences (UIS)

Sant Baba Bhag Singh University

2023

ABOUT THE DEPARTMENT

The Physical Sciences expands our knowledge of the universe and underlines new technologies, which benefit our society. In keeping with the heritage of imparting quality education, teaching and research are the prime motive of the Department of Physical Sciences. Department of Physical Sciences is dynamic and progressive in its development of new course initiatives and to contribute substantially to the goal of SBBSU and becoming a research oriented organization. The teaching is by way of interactive sessions between students and teachers. Our courses ensure a coherent degree structure while encouraging interdisciplinary approach.

Student centric, ICT enabled and interactive teaching, outcome based teaching model comprising of theoretical work, regular academic activities such as research projects, seminars, resource learning and hands-on laboratory work. The Department wishes to focus on providing a comprehensive curriculum at undergraduate and postgraduate levels with teaching- learning adjunct to cater the need of industry, relevant research and career opportunities, meritorious careers in academia and proficient industries. Our research oriented teaching paves the way for entry into different careers since it equips students with advanced transferable skills in information gathering, analysis and presentation, which are vital tools in the field of science.

SALIENT FEATURES OF THE DEPARTMENT

- The department is blessed to have specialized faculty in various fields of Physical Sciences viz. Chemistry, Physics, Mathematics.
- The Department keeps its students abreast of latest advancements in technology through ultra-modern computer facilities, e-learning, virtual labs, SWAYAM Courses as per UGC guidelines
- The department updates curricula on a regular basis to ensure that students keep up with the changing trends of education and research globally. The syllabi of courses are designed to equip students to qualify exams such as GATE, UGC- NET / SLET, TIFR etc.
- The Department has well equipped laboratories with a number of instruments and facilities like, UV- Visible Spectrophotometer, High Speed Centrifuge, Muffle furnance, Digital water bath, Polarimeter, Ultrasonic interferometer, Ballistic Galvanometer , Deflection and vibration Magnetometer , Electron spin resonance, Turbiditimeter, Abbs Refractrometer, Digital weighing balance/ Spring balance, Magnetic plate with stirrer, pH meter, Conductometer, Flame Photometer, colorimeter and a double distillation plant etc.
- Students and teachers participation in International, National, State and Regional seminars and conferences. Along with Industry aligned academia, expert interaction, is the key features of the department.
- Curricular and the co-curricular activities are well balanced in the Teaching Learning environment to provide holistic education to the students.
- The outcome based teaching model of faculty comprising of theoretical work, regular academic activities such as research projects, seminars, resource learning and hands-on laboratory work.
- Along with Industry aligned academia, expert interaction is the key features of the department.

MSc.(HONS.) PHYSICS (MASTER OF SCIENCE HONOURS IN PHYSICS)

MSc. (Hons.) Physics or **Master of Science Honours in Physics** is a postgraduate Physics program. The course helps to train the innovative minds in the latest developments in Physics as applicable in the field of modern inventions and discoveries. The course includes Mathematical Physics, Classical Mechanics, Quantum Mechanics, Electronic Devices, Statistical Mechanics, Electrodynamics, Plasma Physics, Atomic and Molecular Physics, Condensed Matter, Nuclear and Particle Physics. The duration of the course is two years and it is career orienting in nature.

VISION

To aspire, achieve and sustain for excellence in academics and research through scientific knowledge so as to provide solutions to global environmental issues and transform graduates into responsible citizens and competent professionals.

MISSION

- Holistic development of learner through academic excellence, employability, acquisition of analytical skills and higher research.
- To explore and advance new frontiers in physical sciences and integration with interdisciplinary sciences through visionary research for the benefit of society.
- To develop graduates for lifelong learning and professional growth.

ELIGIBILITY CRITERIA

B.Sc. (Pass) with Physics as one of the Core subjects /B.Sc.(Hons.) Physics with 50% marks (45% marks in case of SC/ST candidates) in aggregate or equivalent grade from any university recognized by UGC.

DURATION

2 Years

CAREER PATHWAYS

- The Degree serves as a basis for further higher studies such as Ph.D. and M.Phil. Degree in Physics, the successful completion of which makes one eligible for the post of Assistant Professor in any university/college.
- Multiple pathways designed according to the level of the students to prepare them for different job profiles as per needs of industrial sector.
- They can become a school teacher on private basis after it and lecturer after completing a Master’s degree plus NET exam permanently.

PROGRAMME EDUCATIONAL OBJECTIVE (PEO)

PEO1: Students will have knowledge of fundamental laws and principle in a variety of areas of Physics along with their applications.

PEO2: Develop research skills which might include advance laboratory techniques, numerical techniques, computer algebra, and computer interfacing.

PEO3: Become effective researcher who will be able to provide the summation of scientific literature on a given topic.

PEO4: To create a sense of ethical responsibilities among students.

PEO5: To make the students to accept the challenges in physics and can effectively disseminate the physics knowledge to coming generations.

PEO6: Design solutions for advanced scientific problems and design system components or processes.

PROGRAMME OUTCOMES (PO)

PO1: Disciplinary Knowledge: The student has acquired in-depth knowledge of the various concepts and theoretical principles of Physics and is aware of their manifestations. An understanding of the centrality of Physics is usually evident from familiarity with interfacial disciplines. A graduate in Physics is expected to be thoroughly conversant with all fundamental laws and principle in variety of areas of Physics along with their applications and laboratory techniques.

PO2: Critical thinking: Critical thinking as an attribute enables a student to identify, formulate and analyze a complex variety of problems in Physics. A graduate in Physics is expected to assess, reconstruct and solve the problem

PO3: Problem solving: A vital part of Physics curriculum is problem solving. The student will be well-equipped to solve complex problems of numerical related to engineering/Physics that are best approached with critical thinking.

PO4: Scientific /Analytical reasoning: Students learn to investigate, experiments/ theoretical methods, relate information and interpretation of data based on scientific reasoning. The student will be able to draw logical conclusions based on a group of observations, mathematical techniques and measurements.

PO5: Modern tool usage: Increasing the usage of appropriate techniques, resources having interface with computers and use of computers in laboratory work creates this attribute. A student with degree in Physics is able to employ knowledge and skill in computers in a variety of situations- data analysis, coding of complex physics problems as well as information retrieval and library use.

PO6: Multicultural Competence: Development of a set of competencies in order to enhance and promote the growth of multicultural sensitivity with in universities to assess societal, health, safety, legal and cultural issues. Ingrating multicultural awareness such as race, gender, physical ability, age, income and other social variables and by creating an environment that is, “welcoming for all students".

PO7: Environment & Sustainability: Understand the impact of the scientific solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Research related skills & Ethics: Develop skills for critically review scientific information and become able to comprehend and write effective reports and design documentation. Able to create a sense of ethical responsibilities among students. The student is aware of what constitutes unethical behaviour-- plagiarism, fabrication and misrepresentation or manipulation of data.

PO9:Self-directed learning: Students are encouraged to accept challenges in Physics by information available to them. Various activities/advanced ideas require the students to find relevant information and educate themselves.

PO10: Individual and team work: Leadership is essential in making teamwork into a reality. Working in teams promotes both teamwork and leadership qualities in the student. Teams may comprise of peers in classroom, laboratory or any other team of members from diverse fields. The student is capable of contributing meaningfully to team ethos and goals.

PO11: Communication skills: Effective communication is a much desirable attribute across courses. However, a Physics student is expected to assimilate technical information and convey it to intended audience, both orally and in writing in an intelligible manner.

PO12: Lifelong learning: Having a strong conceptual framework in the subject along with the skills of teamwork, analytical reasoning, problem solving, critical thinking etc. make the students lifelong learners.

PROGRAMME SPECIFIC OUTCOMES (PSO)

PSO1: Explain and apply principles of physics for understanding the scientific aspects in classical domain.

PSO2: Explain and apply mathematical techniques for illustrating and deeper understanding of physical systems.

PSO3: Learn and apply statistical methods for portraying the classical and quantum particles in various physical systems.

PSO4: Learn and apply inter-disciplinary concepts and computational skills for interpreting and describing the different phenomenon in physics.

PSO5: Learn and apply advanced experimental/theoretical methods for measurement, observation, and fundamental understanding of physical phenomenon/system.

PSO6: Provide exposure in research in various specializations of Physics like (Solid State Physics/Nuclear Physics/Particle Physics/Radiation Physics etc).

Curriculum Structure: MSc. (Hons.) Physics as per NEP

MSc. (Hons.) Physics degree programme will have a curriculum with Syllabi consisting of following type of courses:

I. **Major Courses (Major):** A course, which should compulsorily studied by a candidate as a core requirement is termed as a Major course. These courses are employability enhancement courses relevant to the chosen program of study. Program core comprises of Theory, Practical, Project, Seminar etc. Project work is considered as a special course involving application of knowledge in solving/ analyzing/exploring a real life situation/ difficult problem.

II. **Elective Courses:** Elective course is generally a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/subject of study or with provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill. Accordingly, elective course may be categorizes as:
   A. Major Discipline Specific Elective Course Major (DSE): Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective.
   B. Dissertation: An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project/ Dissertation work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project.

III. **Minor Courses (Minor):** A course, which should compulsorily by studied by a candidate as per requirement of syllabi is termed as a Minor course. These courses are employability enhancement courses relevant to the chosen program of study.

IV. **Value Added & Multidisciplinary Courses:** VAC & MDC courses are value-based and/or skill-based and are aimed at providing competencies, skills, etc.

V. **Skill Enhancement Courses (SEC):** These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based knowledge.

2. NOMENCLATURE USED:

Major: Major Course
Minor: Minor Course
Major DSE: Major Discipline Specific Elective
VAC: Value Added course
MDC: Multidisciplinary Course
SEC: Skill Enhancement Course

Index

			Mathematical Sciences		
19	Major(DSE)	PHY651 PHY653 PHY655 PHY657	**Choose any one** a) Nanotechnology b) Physics of Nanomaterial c) Spintronics d) Theoretical Aspects of Nuclear Structure Physics	III	57-63
20	Major(DSE)	PHY659 PHY661 PHY663 PHY665	**Choose any one** a) Plasma Physics b) Radiation Physics c)Introduction to NMR Spectroscopy d)Fluid Dynamics	III	64-68
21	Minor	PHY667	Instrumental Methods of Analysis	III	69-70
22	Minor	RM655	Publication and Research Ethics	III	71-72
23	Major	PHY669	Dissertation- I	III	73
24	Minor	PHY671	Seminar & Summer Training	III	74
25	Major	RM654	Advances in Research Methodology in Physical and Mathematical Sciences	IV	76-77
26	Major(DSE)	PHY652 PHY654 PHY656 PHY658	**Choose any one:** a)Solar Cells and its Applications b) Polymers &Liquid Crystal c) Thin Film Technology d)Non-Linear Fibre Optics	IV	78-83
27	Major(DSE)	PHY660 PHY662 PHY664 PHY666	**Choose any one:** a) Physics of Low Dimensional Semiconductors b) Geophysics c) Non- Linear Dynamics d)Introduction to Astrophysics	IV	84-90
28	Major	PHY668	Dissertation -II	IV	91
29	Minor	RM656	Scientific and Technical Writing	IV	92-93

Major Courses

Sr. No.	Subject Code	Subject	Semester	Page No
1.	PHY551	Quantum Mechanics	I	16-17
2.	PHY553	Classical Mechanics	I	18-19
3.	PHY555	Mathematical Physics	I	20-21
4.	PHY565	Electronics Lab	I	30-31
5.	PHY567	Computer Lab	I	32
6.	PHY552	Electrodynamics	II	34-35
7.	PHY554	Condensed Matter Physics	II	36-37
8.	PHY556	Atomic & Molecular Spectroscopy	II	38-39
9.	PHY568	Condensed Matter Physics Lab	II	50-51
10.	PHY570	Atomic & Molecular Spectroscopy Lab	II	52-53
11.	RM653	Basics of Research Methodology in Physical and Mathematical Sciences	III	55-56
12.	PHY669	Dissertation-I	III	73
13.	RM654	Advances in Research Methodology in Physical and Mathematical Sciences	IV	76-77
14.	PHY668	Dissertation-II	IV	91

Minor Courses

Sr. No.	Subject Code	Subject	Semester	Page No
1	PHY557	Electronics	I	27
2	PHY558	Nuclear &Particle Physics	II	46-47
3	PHY667	Instrumental Methods of Analysis	III	69-70
4	RM655	Publication and Research Ethics	III	71-72
5	PHY671	Seminar & Summer Training	III	74
6	RM656	Scientific and Technical Writing	IV	92-93

Value Added &Multidisciplinary Courses

Sr. No.	Subject Code	Subject	Semester	Page No
1.	EVS003	Natural Hazards & Disaster Management	I	28-29
2.	CHM580	Structures, Spectra and Properties of Biomolecules	II	48-49

Major Discipline Specific Courses

Sr. No.	Subject Code	Subject	Semester	Page No
1	PHY559 PHY561 PHY563	**Choose any one** a)Computational Techniques b) Reactor Physics c)Science of Renewable Energy Sources	I	22-26
2	PHY560 PHY562 PHY564	**Choose any one** a) Statistical Mechanics b) Instrumentation and Experiment Design c)Fabrication of Electronic Devices	II	40-45
3	PHY651 PHY653 PHY655 PHY657	**Choose any one** a)Nano Technology b)Physics of Nanomaterial c)Spintronics d) Theoretical Aspects of Nuclear Structure Physics	III	57-63
4	PHY659 PHY661 PHY663 PHY665	**Choose any one** a)Plasma Physics b)Radiation Physics c)Introduction to NMR Spectroscopy d) Fluid Dynamics	III	64-68
5	PHY652 PHY654 PHY656 PHY658	**Choose any one** a)Solar Cells and its Applications b)Polymers &Liquid Crystal c)Thin Film Technology d) Non-Linear Fibre Optics	IV	78-83

6	PHY660 PHY662 PHY664 PHY666	**Choose any one** a)Physics of Low Dimensional Semiconductor b)Geophysics c)Non-Linear Dynamics d)Introduction to Astrophysics	IV	84-90

Scheme for M.Sc.(Hons.) Physics as per NEP 2020

Semester-I

I. Theory Subjects

S.No.	Type of Course	Subject Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credits Hours
1	Major	PHY551	Quantum Mechanics	4:0:0	4:0:0	4	4
2	Major	PHY553	Classical Mechanics	4:0:0	4:0:0	4	4
3	Major	PHY555	Mathematical Physics	4:0:0	4:0:0	4	4
4	Major(DSE)	PHY559 PHY561 PHY563	**Choose any one:** a.)Computational Techniques b.)Reactor Physics c)Science of Renewable Energy Sources	4:0:0	4:0:0	4	4
5	Minor	PHY557	Electronics	4:0:0	4:0:0	4	4
6	VAC	EVS003	Natural Hazards & Disaster Management	3:0:0	3:0:0	3	3

II. Practical Subjects

1	Major	PHY565	Electronics Lab	0:0:4	0:0:2	4	2
2	Major	PHY567	Computer Lab	0:0:4	0:0:2	4	2
					Total	**31**	**27**

Total Contact Hours: 31
Total Credit Hours: 27

Major: Major Course
Minor: Minor Course
Major (DSE): Major Discipline Specific Elective Courses
VAC: Value Added Course

Scheme for M.Sc. (Hons.) Physics as per NEP 2020
Semester II

I. Theory Subjects

S.No.	Type of Course	Subject Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credits Hours
1	Major	PHY552	Electrodynamics	4:0:0	4:0:0	4	4
2	Major	PHY554	Condensed Matter Physics	4:0:0	4:0:0	4	4
3	Major	PHY556	Atomic & Molecular Spectroscopy	4:0:0	4:0:0	4	4
4	Major(DSE)	PHY560 PHY562 PHY564	**Choose any one**: a) Statistical Mechanics b)Instrumentation and Experiment Design c)Fabrication of Electronic Devices	4:0:0	4:0:0	4	4
5	Minor	PHY558	Nuclear & Particle Physics	4:0:0	4:0:0	4	4
6	MDC	CHM580	Structures, Spectra and Properties of Biomolecules	3:0:0	3:0:0	3	3

II. Practical Subjects

1	Major	PHY568	Condensed Matter Physics Lab	0:0:4	0:0:2	4	2
2	Major	PHY570	Atomic& Molecular Spectroscopy Lab	0:0:4	0:0:2	4	2
					Total	**31**	**27**

Total Contact Hours: 31
Total Credit Hours: 27

Major: Major Course
Minor: Minor Course
Major (DSE): Major Discipline Specific Elective Courses
MDC: Multidisciplinary Course
***Students have to apply for summer or Industrial Training/Internship after completion of their 2nd sem End Semester Exam.**

Scheme for M.Sc. (Hons.) Physics as per NEP2020
Semester III

I. Theory Subjects

S.No.	Type of Course	Subject Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credits Hours
1	Major	RM653	Basics of Research Methodology in Physical and Mathematical Sciences	4:1:0	4:1:0	5	5
2	Major(DSE)	PHY651 PHY653 PHY655 PHY657	**Choose any one:** a)Nanotechnology b)Physics of Nanomaterials c) Spintronics d)Theoretical Aspects of Nuclear Structure Physics	4:0:0	4:0:0	4	4
3	Major(DSE)	PHY659 PHY661 PHY663 PHY665	**Choose any one:** a) Plasma Physics b) Radiation Physics c) Introduction to NMR Spectroscopy d)Fluid Dynamics	4:0:0	4:0:0	4	4
4	Minor	PHY667	Instrumental Methods of Analysis	2:0:0	2:0:0	2	2
5	Minor	RM655	Publication and Research Ethics	2:0:0	2:0:0	2	2

II. Practical Subjects

1	Major	PHY669	Dissertation-I	0:0:8	0:0:4	8	4
2	Minor(SEC)	PHY671	Seminar & Summer Training	0:0:4	0:0:2	4	2
					Total	**29**	**23**

Total Contact Hours: 29
Total Credit Hours: 23

Major (DSE): Major Discipline Specific Elective Courses
Major: Major Courses
Minor: Minor Course
SEC: Skill Enhancement Course

- **Evaluation of dissertation-I will be based on submission of synopsis and approved research objectives through DRC committee of the department.**

Scheme for M.Sc. (Hons.) Physics as per NEP 2020
Semester IV

I. Theory Subjects

S. No.	Type of Course	Subject Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credits Hours
1	Major	RM654	Advances in Research Methodology in Physical and Mathematical Sciences	4:1:0	4:1:0	5	5
2	Major(DSE)	PHY652 PHY654 PHY656 PHY658	**Choose any one:** a)Solar Cells and its Applications b) Polymers &Liquid Crystal c) Thin Film Technology d) Non- Linear Fibre Optics	4:0:0	4:0:0	4	4
3	Major(DSE)	PHY660 PHY662 PHY664 PHY666	**Choose any one:** a) Physics of Low Dimensional Semiconductors b) Geophysics c) Non-Linear Dynamics d) Introduction to Astrophysics	4:0:0	4:0:0	4	4

II. Practical Subject

1	Major	PHY668	Dissertation-II	0:0:16	0:0:8	16	8
2	Minor	RM656	Scientific &Technical Writing	0:0:4	0:0:2	4	2
					Total	**33**	**23**

Total Contact Hours: 33

Total Credit Hours: 23

Major (DSE): Major Discipline Specific Elective Courses
Major: Major Courses
Minor: Minor Courses
***Evaluation of dissertation-II will be based on submission of evaluation of complete dissertation through institutional RDC.**

Summarized Report of Course Scheme for M.Sc.(Hons.) Physics (as per NEP)										
SEM	**L**	**T**	**P**	**Contact hrs./week**	**Credits hrs./week**	**Major**	**Minor**	**Major(DSE)**	**VAC**	**MDC**
I	**23**	**0**	**08**	**31**	**27**	**12**	**4**	**4**	**3**	**0**
II	**23**	**0**	**08**	**31**	**27**	**12**	**4**	**4**	**0**	**3**
III	**16**	**1**	**12**	**29**	**23**	**5**	**4**	**8**	**0**	**0**
IV	**12**	**1**	**20**	**33**	**23**	**5**	**0**	**8**	**0**	**0**
Total	**74**	**2**	**48**	**124**	**100**	**34**	**12**	**24**	**3**	**3**

SEMESTER I

Course Code	**PHY551**
Course Title	**Quantum Mechanics**
Type of course	Major
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	To connect the historical development of quantum mechanics with previous knowledge and learn the basic properties of quantum world.
Course Outcomes(CO)	**Students will able:** CO1: To apply different types of ket-bra notations, operators and determine commutation relations & to study the importance of perturbation theory in quantum mechanics. CO2: To learn and apply one dimensional system including step potential, potential barrier on quantum mechanics problem and study their energy eigen states and scattering theories. CO3: To study the importance of relativistic quantum mechanics compared to non-relativistic quantum mechanics. & to distinguish between identical and non-identical particles. CO4: To describe the orbital angular momentum and spin angular momentum theory, identical and non-identical particles and will be able to calculate CG coefficients.

UNIT-I

Basic Formulation and Perturbation Theory: Stern Gerlach experiment as a tool to introduce quantum ideas, Complex linear vector spaces, Ket-bra space, inner product, operators and properties of operators. Eigenkets of an observable, eigenkets as base kets, matrix representations, compatible vs. incompatible observable, commutators and uncertainty relations. Change of basis and unitary transformations, translation, momentum as a generator of translations, Wave functions as position representation of ket vectors, Momentum operator in position representation, momentum space wave function, time dependence of expectation values, Schrodinger vs. Heisenberg picture, unitary operators, state kets and observable in Schrodinger and Heisenberg pictures, Heisenberg equations of motion, Ehrenfest's theorem.

First and second order perturbation theory for non-degenerate and degenerate systems. Perturbation of an oscillator, the variation method, First order time dependent perturbation theory, Calculation of transition probability per unit time for harmonic perturbation, The Helium atom problem, Stark effect, WKB approximation.

UNIT-II

One Dimensional System & Scattering Theory: Potential Step, potential barrier, potential well, scattering vs. Bounds states. Simple harmonic oscillator, wave functions and coherent states. Born approximation, extend to higher orders, Validity of Born approximation for a square well potential, Optical theorem, Partial wave analysis, unitarity and phase shifts, Determination of phase shift, applications to hard sphere scattering, Low energy scattering in case of bound states, Resonance scattering.

UNIT-III

Relativistic Quantum Mechanics & Identical Particles: Klein Gordon equation. Dirac Equation, Lorentz covariance of Dirac equation, Positive and negative energy solutions of Dirac equation, positrons, Properties of gamma matrices, Parity operator and its action on states, Magnetic moments and spin orbit energy, Brief introduction to identical particles in quantum mechanics (based on Feynmann Vol.III), symmetrisation postulates, Application to 2-electron systems, Pauli Exclusion Principle, Bose Einstein and Fermi Dirac Statistics.

UNIT-IV

Spherical Symmetric Systems and Angular momentum: Schrodinger equation for a spherically symmetric potential. Orbital angular momentum commutation relations. Eigen value problem for L2and Lz, spherical harmonics. Three dimensional harmonic oscillator, three dimensional potential well and the hydrogen atom. Angular momentum algebra, commutation relations. Introduction to the concept of representation of the commutation relations in different dimensions. Eigen vectors and eigen functions of J2and Jz. Addition of angular momentum and C.G. coefficients.

Text and Reference Books:

S. No	Name	Author(S)	Publisher
1	Modern Quantum Mechanics	J.J. Sakurai	Pearson Educaton Pvt. Ltd., New Delhi, 2002
2	Quantum Mechanics	L I Schiff	Tokyo Mc Graw Hill, 1968
3	Feynmann lectures in Physics Vol. III	Addison Wesly, 1975	Prentice Hall
4	Introduction to Quantum Mechanics	David J. Griffith	Prentice Hall
5	Quantum Mechanics (Concept and Application)	N.Zettili	John Wiley &Sons, Ltd
6	Quirky Quantum Concepts	Eric L. Michelsen	Springer

Course Code	**PHY553**
Course Title	**Classical Mechanics**
Type of course	Major
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	This course will impart the knowledge of Classical Mechanics to students.
Course Outcomes (CO)	**Students will able:** CO1: To understand about the mechanics of system of particles, Lagrangian and Hamiltonian formulations in classical mechanics. CO2: To determine distinct problems related with central force including Kepler's laws of motion. CO3: To understand the idea about Euler's equations of motion of rigid body. CO4: To apply the theories and mathematical equations related to Canonical Transformations.

UNIT-I

Lagrangian Mechanics: Newton's laws of motion, mechanics of a system of particles, constraints, D' Alembert's principle and Lagrange equations of motion. Velocity dependent potentials and dissipation function. Some applications of Lagrangian formulation, Hamilton's principle, derivation of Lagrange equations from Hamilton's principle. Conservation theorems and symmetry properties.

UNIT-II

Central Force Problem: Two body central force problem, reduction to equivalent one body problem, the equation of motion and first integrals, the equivalent one dimensional problem, and classification of orbits. The differential equation for the orbit and integrable power-law potential. The Kepler problem. Scattering in a central force.

UNIT-III

Rigid Body Dynamics: The independent coordinates of a rigid body, orthogonal transformation, Euler's angles. Eulers' theorem on the motion of rigid body, finite and infinitesimal rotations, rate of change of a vector, angular momentum and kinetic energy about a point for a rigid body, the inertia tensor and moment of inertia, Eigen values of the moment inertia tensor and the principal axis transformation. Euler's equations of motion, torque free motion of a rigid body.

UNIT-IV

Canonical Transformations: Legendre transformation and Hamilton equations of motion, cyclic coordinates and conservation theorems, derivation of Hamilton's equations from a variational principle, the principle of least action. The equations of canonical transformation, examples of canonical transformations, Poisson brackets. Equations of motion, infinitesimal canonical transformations and conservation theorems in the Poisson bracket formulation.

Text and Reference Books:

S. No.	Name	Author(S)	Publisher
1	Classical Mechanics	Herbert Goldstein	Narosa Pub. House, New Delhi,
2	Mechanics	L. D. Landau and E. M. Lifshitz	Pergamon Press, Oxford, 1982
3	Classical Mechanics	N. C. Rana and P. S. Joag	Tata Mc Graw Hill, New Delhi,

Course Code	**PHY555**
Course Title	**Mathematical Physics**
Type of course	Major
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	The main objective of this course is to familiarize students with a range of mathematical methods that are essential for solving advanced problems in theoretical physics.
Course Outcome (CO)	**Students will able:** CO1: To understand the general coordinate transformations, their relevant transformation equations, basic tensor algebra, covariant- and contra-variant tensors and Fourier series. CO2: To learn various special functions, solve corresponding differential equations and understand about their properties. CO3: To determine accurate and efficient use of complex analysis techniques. CO4: To describe the basics of Group Theory.

UNIT-I

Fourier Transformation: Fourier decomposition, Fourier series and convolution theorem. Fourier transformations and its applications to wave theory.

Coordinate Systems: Curvilinear coordinates, Differential vector operators in curvilinear coordinates, Spherical and cylindrical coordinate systems, General coordinate transformation. **Tensors:** covariant, contravariant and mixed, Algebraic operations on tensors, Illustrative applications.

UNIT-II

Differential Equations: Second order differential equations, Frobenius method, Wronskian and a second solution, the Sturm Lioville problem, one dimensional Greens function.

Special functions: Gamma function, The exponential integral and related functions, Bessel functions of the first and second kind, Legendre polynomials associated Legendre polynomials and spherical harmonics, Generating functions for Bessel, Legendre and associated Legendre polynomials.

UNIT-III

Complex Analysis: The Cauchy-Riemann conditions, Cauchy integral theorem. Taylor and Laurent series, singularities and residues, Cauchy residue theorem, Calculation of real integrals.

UNIT-IV

Group Theory: Definition of a group, multiplication table, conjugate elements and classes of groups, direct product, Isomorphism, homeomorphism, permutation group, Definitions of the three dimensional rotation group and SU(2).

Text and Reference Books:

S.No.	Name	Author(S)	Publisher
1	Mathematical Methods for Physicists	George Arfken	New York Academy, 1970.
2	Advanced Mathematical	George Stephenson	Cambridge Uni Press,

	Methods for Engg. and Science Students	and P.M. Radmore	1990
3	Applied Mathematics for Engineers & Physicists	Harvil and Pipes	Prentice Hall

Course Code	**PHY559**
Course Title	**Computational Techniques**
Type of course	Major(DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	The objective of the course is to give student knowledge about different numerical method for solving problem, related to theoretical physics.
Course Outcomes(CO)	**Students will able:** CO1: To solve various examples for interpolation, least square fitting and cubic splines. CO2: To solve the problem related to integration and differentiation numerically. CO3: To calculate the root of equation using bisection, regula falsi,newton-raphson method,etc & to apply different numerical methods for solving non-linear and linear system of equations. CO4: To solve ordinary differential equations.

UNIT-I

Interpolation: Interpolation, Newton's formula for forward and backward interpolation, divided differences, Newton's general interpolation formula, Lagrange's interpolation formula, Cubic splines, Least square approximation.

UNIT-II

Numerical Differentiation and Integration: Derivatives using forward and backward difference formula, Numerical integration, general quadrature formula for equidistant ordinates, Simpson, Weddle and Trapezoidal rules, Romberg integration, Gauss quadrature formula.

UNIT-III

Roots of Equation: Approximate values of roots, Bisection Method, Regula-Falsi Method, Newton-Raphson method. Simultaneous Linear Algebraic Equations: Solution of Simultaneous Linear equations, Gauss elimination method, Gauss-Jordon method, Matrix inversion, Iterative methods: Jacobi iteration method, Gauss Seidel iteration method.

UNIT-IV

Ordinary Differential Equation: Euler's method, Modified Euler's method, Runge-Kutta Method, system of coupled first order ordinary differential equations. Partial differential equations: An elementary idea about numerical solution of partial differential equations using finite difference method.

Text and Reference Books:

S. No.	Name	Author(S)	Publisher
1	Numerical Methods for Engineers	Steven C Chapra, Raymond P Canale	Tata McGraw-Hill
2	Numerical Mathematical Analysis	Scarbrough James B	Oxford and IBH Publishing Company

3	Numerical methods	BS Grewal	

Course Code	**PHY561**
Course Title	**Reactor Physics**
Type of course	Major(DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	The aim of the subject is to provide the knowledge about nuclear reactors.
Course Outcomes (CO)	**Students will able:** CO1: To understand the interaction of neutron with matter. CO2: To study the detail aspects of moderation of neutrons. CO3: To study homogenous and heterogeneous reactor assemblies. CO4: To get detail information of power reactors.

UNIT-I

Interaction of Neutrons with Matter in Bulk: Thermal neutron diffusion, Transport and diffusion equations, transport mean free path, solution of diffusion equation for a point source in an infinite medium and for an infinite plane source in a finite medium, extrapolation length and diffusion length-the albedo concept.

UNIT-II

Moderation of Neutron: Mechanics of elastic scattering, energy distribution of thermal neutrons, average logarithmic energy decrement, slowing down power and moderating ration of a medium. Slowing down density, slowing down time, Fast neutron diffusion and Fermi age theory, solution of age equation for a point source of fast neutrons in an infinite medium, slowing down length and Fermi age.

UNIT-III

Theory of Homogeneous Bare Thermal and Heterogeneous Natural Uranium Reactors: Neutron cycle and multiplication factor, four factor formula, neutron leakage, typical calculations of critical size and composition in simple cases, The critical equation, material and geometrical buckling, effect of reflector, Advantages and disadvantages of heterogeneous assemblies, various types of reactors with special reference to Indian reactors and a brief discussion of their design feature.

UNIT-IV

Power Reactors Problems of Reactor Control: Breeding ratio, breading gain, doubling time, Fast breeder reactors, dual purpose reactors, concept of fusion reactors, Role of delayed neutrons and reactor period, In hour formula, excess reactivity, temperature effects, fission product poisoning, use of coolants and control rods.

Text and Reference Books:

S. No	**Name**	**Author(S)**	**Publisher**
1	The elements of Nuclear reactor Theory	Gladstone & Edlund	Vam Nostrand, 1952
2	Introductions of Nuclear Engineering	Murray	Prentice Hall, 1961

Course Code	**PHY563**
Course Title	**Science of Renewable Energy Sources**
Type of course	Major(DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	The aim and objective of the course on Science of renewable Energy Sources is to expose the M.Sc. students to the basics of the alternative energy sources like solar energy, hydrogen energy, etc.
Course Outcomes (CO)	**Students will able:** CO1: To know the energy demand of world and India. CO2: To understand the solar energy and different concepts to develop solar physics applications. CO3: To understand in general the production of hydrogen through solar energy and their storage applications. CO4: To study in detail about the wind energy, nature of wind, and their electronics applications.

UNIT-I

Production and reserves of energy sources: Production and reserves of energy sources in the world and in India need for alternatives, renewable energy sources.

UNIT-II

Thermal applications: solar radiation outside the earth's atmosphere and at the earth's surface, fundamentals of photovoltaic energy conversion. Direct and indirect transition semi-conductors, interrelationship between absorption coefficients and band gap recombination of carriers. Types of solar cells, p-n junction solar cell, Transport equation, current density, open circuit voltage and short circuit current, description and principle of working of single crystal, polycrystalline and amorphous silicon solar cells, conversion efficiency. Elementary ideas of Tandem solar cells, solid-liquid junction solar cells and semiconductor-electrolyte junction solar cells. Principles of photoelectrochemical solar cells. Applications.

UNIT-III

Production of Solar hydrogen: Solar hydrogen through photo electrolysis and photocatalytic process, physics of material characteristics for production of solar hydrogen. Storage processes, solid state hydrogen storage materials, structural and electronic properties of storage materials, new storage modes, safety factors, use of hydrogen as fuel; use in vehicles and electric generation, fuel cells, hydride batteries.

UNIT-IV

Nature of wind: classification and descriptions of wind machines, power coefficient, energy in the wind, wave energy, ocean thermal energy conversion (OTEC), system designs for OTEC.

Text and Reference Books:

S. No	**Name**	**Author(S)**	**Publisher**
1	Solar Energy	S.P. Sukhatme	Tata McGraw-Hill, New Delhi
2	Solar cell devices	Fonash	Academic Press New York
3	Fundamentals of solar cell,	Fahrenbruch and Bube	Springer Berlin !983

	photovoltaic solar energy		

Course Code	**PHY557**
Course Title	**Electronics**
Type of course	Minor
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objectives	The aim of the subject is to enhance the knowledge of students about various electronic circuits, electronic devices and its applications.
Course Outcome (CO)	**Students will able:** CO1: To get to know about the working of various electronic devices. CO2: To gain basic knowledge of OPAMP and their applications in different areas. CO3: To understand the basics of digital electronics. CO4: To analyze various combinational and sequential circuits.

UNIT-I

Semiconductor Devices: Energy Bands, Intrinsic carrier concentration, Donors and Acceptors, Direct and Indirect band semiconductors, FET, MESFET, MOSFET, Unijunction transistor (UJT), four layer (PNPN) devices, construction and working of PNPN diode, Semiconductor controlled rectifier (SCR), Thyristor, solar cells, photo-detectors, LEDs.

UNIT-II

Electronic Circuits: Differential amplifier, Operational amplifier (OP-AMP), Open loop Op-Amp, OP-AMP as inverting and non-inverting, scalar, summer, integrator, differentiator, Difference and Common mode gain, Common Mode rejection ratio. Schmitt trigger, Comparator.

Digital Principles: Binary and Hexadecimal number system, Binary arithmetic, Logic gates, Boolean equation of logic circuits.

UNIT-III

Combinational Circuits: Digital-to-Analog Converter, Ladder type, Analog-to-digital Convertor, Successive Approximation converter.

Combinational Logic: The transistor as a switch, OR, AND , NOT Gates, NOR and NAND, Exclusive OR gates, Boolean algebra, Demorgan's theorems, Parity generators and checkers, Adder-Subractor circuits. Karnaugh maps, Decoder/Demultiplexer, Data selector/multiplexer, Encoder.

UNIT-IV

Sequential Circuits: RS Flip Flops, D Flops, JK flip flop, JK Master Slave, T flip flop, Shift Registers, Up/Down counters, Synchronous and Asynchronous counters, Mod counters, Memory devices: static and dynamic Random Access memories, SRAM and DRAM, CMOS and NMOS.

Text and Reference Books:

S.No.	**Name**	**Author(S)**	**Publisher**
1	Electronic Devices and Circuits	Millman and Halkias	Tata McGraw-Hill
2	Solid State Electronic Devices	Ben G Streetman and Banerjee	Prentice-Hall of India
3	Digital Principles and Applications	P. Malvino and D.P.Leach	Tata McGraw-Hill

Course Code	**EVS003**
Course Title	**Natural Hazards & Disaster Management**
Type of course	VAC
L T P	3 0 0
Credits	3
Course prerequisite	B.Sc. Non Medical/Medical
Course Objective	To learn about natural hazards, risk assessment and disaster management.
Course Outcomes(CO)	**Students will able:** CO1: To know the current overview of natural hazard materials. CO2: discuss the physical aspects of vulnerability and elements of risk mapping, assessment. CO3: know the development planning, sustainable development in the context of Climate Change.

UNIT-I

Overview of natural hazards; Introduction to natural hazards, impact and mitigation in Global and Indian context; causes and consequences of geological hazards, flood, drought and climate change issues, forest hazard, tsunami and coastal hazards, cyclone hazards, snow avalanche, GLOF and glacier related hazards, extreme weather events, urban and industrial hazards.

UNIT-II

Introduction to vulnerability and risk assessment, socio-economic and physical aspects of vulnerability and elements of risk mapping, assessment, and reduction strategies.

UNIT-III

Earth observation: Data availability and key operational issues for DM: EO systems for natural hazards study: present (operational) and future systems; multi-temporal data sources, multi-temporal database organisation: Key operational issues, utilisation of geo-information products for disaster management (available through international cooperation e.g. International Charter etc.)

UNIT-IV

Disaster management framework of India and recent initiatives by Govt. of India with special emphasis on DRR HFA 2005-2015, MDG and SAARC comprehensive framework for DRR Disaster Management Support (DMS): Status in India for use of space inputs Mainstreaming DRR in Development Planning Sustainable development in the context of Climate Change Disaster Recovery-Strategy and case examples

Text and Reference Books

S. No	Name	Author(S)	Publisher
1	Environmental Hazards : Assessing Risk and Reducing Disaster	Keith Smith and Petley David, 2008	Routledge
2	Geo-information for Disaster	van Oosterom Peter,	Springer-Verlag

	Management	Zlatanova Siyka and Fendel Elfriede, 2005	
3	Geospatial Techniques in Urban Hazards and Disaster Analysis	Showalter, Pamela S. and Lu, Yongmei, 2010	John Wiley and Sons.
4.	An International Perspective on Natural Disaster: Occurrence, Mitigation and Consequences	Stoltman JP, Lidstone J and Dechano LM., 2004.	Kluwer Academic Publishers

Course Code	**PHY565**
Course Title	**Electronics Lab**
Type of course	Major
L T P	0 0 4
Credits	2
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	The aim of this course is to impart practical knowledge to the students about Electronics devices, and have an understanding of how it works.
Course Outcomes(CO)	**Students will able:** CO1: To perform the analysis and design of electrical circuits. CO2: To understand the practical concept behind the design of any electrical designs. CO3: To study the output in different operating modes of different semiconductor devices. CO4: To make mini as well as major projects related to electronics.

***Note: From each section students has to do any of the two experiments.**

Electronic devices:

1. To Study the DC characteristics and applications of DIAC.
2. To study the DC characteristics and applications of SCR.
3. To study the DC characteristics and applications of TRIAC.
4. Investigation of the DC characteristics and applications of UJT.
5. Investigation of the DC characteristics of MOSFET.
6. Study the characteristics of FET.

Multivibrators:

1. Study of bi-stable multivibrators.
2. Study of mono-stable multivibrators.
3. Study of astable multivibrators.

Study of Op-Amps and their applications:

1. Study of Op-Amps as an amplifier (inverting, non-inverting).
2. Study of basic properties of Op-Amps as scalar.
3. Study of basic properties of Op-Amps as summer.
4. Study of basic properties of Op-Amps as differentiator.
5. Study of basic properties of Op-Amps as integrator.

Combinational Circuits:

1. Study of logic gates using discrete elements and universal gates.
2. Study of encoder, decoder circuit.
3. Study of arithmetic logic unit (ALU) circuit.
4. Study of half and full adder circuits.
5. Study of A/D and D/A circuits.
6. Digital logic trainer (logic gates, Boolean’s identity and de-Morgan’s theorem).
7. Parity generator and checker.

Sequential Circuits:

1. Study of shift registers.
2. To study JK, MS and D-flip flops.
3. To study 4-bit counter (Synchronous and asynchronous).
4. Study of RAM kit.

Microprocessor 8085:

1. Study of microprocessor 8085 for simple programming in addition.
2. Study of microprocessor 8085 for simple programming in subtraction.
3. Study of microprocessor 8085 for simple programming in multiplication.
4. Study of microprocessor 8085 for simple programming in division.

Text and Reference Books

S. No	Name	Author(S)	Publisher
1	Practical Physics	C. L. Arora	S. Chand
2	Advanced Practical Physics for students	B.L.Flint and H.T.Worsnop	1971, Asia Publishing House
3	Engineering Practical Physics	S.Panigrahi & B.Mallick	Cengage Learning India Pvt. Ltd. 2015
4.	A Text Book of Practical Physics	Indu Prakash and Ramakrishna	11th Edition, 2011, Kitab Mahal, New Delhi.
5.	Advanced level Physics Practicals	Michael Nelson and Jon M. Ogborn,	4th Edition, reprinted 1985, Heinemann Educational Publishers.

Course Code	**PHY567**
Course Title	**Computer Lab**
Type of course	Major
L T P	0 0 4
Credits	2
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	The aim of the course is to impart the practical knowledge about implementation of C++ for solving computational problems.
Course Outcomes(CO)	**Students will able:** CO1: To gain basic knowledge of programming skills of C++ . CO2: To understand the basic mathematical operations in C++ . CO3: To understand the "for" and "if" statements. CO4: To understand the generation of random numbers and read and write a file.

1) Simple mathematical operations like addition, subtraction, division and multiplication.
(2) Calculate the roots of a quadratic equation.
(3) Roots of an equation using bisection method.
(4) Integration using Trapezoidal rule.
(5) Integration using Simpson rule.
(6) Differential equation using Eulers method.
(7)Differential equations using Runge Kutta method.
(8) Matrix multiplication.
(9) Random number generation: writing a file reading numbers from a file.
10) Calculate the value of pi using random number.
(11) Integration using random numbers.

. **Text and Reference Books:**

S. No.	**Name**	**Author(S)**	**Publisher**
1	Object Oriented Programming with C++, 8th edition	E.Balagurusamy	Mc Graw Hill
2	C++ Solutions: Companion to the C++ Programming Language,3RD edition	David Vandevoorde	Addison-Wesley
3	Numerical Recipes 3rd Edition: The Art of Scientific Computing	Willam H Press, Saul A. Teukolsky, Willam T. Vetterling	Cambridge University Press

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SEMESTER II

Course Code	**PHY552**
Course Title	**Electrodynamics**
Type of course	Major
L T P	4 0 0
Credits	4
Course Prerequisite	B.Sc. with physics as one of major subjects
Course Objective	The objectives of the course are to introduce the student to electrodynamics at a theoretically level.
Course Outcomes(CO)	**Students will able:** CO1: To explain fundamentals and applications of various laws in electrostatics & magnetostatics. CO2: To solve Maxwell equations in free space and for harmonically varying fields, electromagnetic wave equations in conducting as well as in non-conducting media and to gain understanding of the phenomenon of reflection, refraction and polarization. CO4: To understand the concept of different wave guides& relativistic formulation of electrodynamics.

UNIT-I

Electrostatics & Magnetostatics: Coulomb's law, Gauss's law, Poisson's equation, Laplace equation. Solution of boundary value problem: Green's function, method of images and calculation of Green's function for the image charge problem in the case of a sphere, uniqueness theorem, Electrostatics of dielectric media, multipole expansion, Boundary value problems in dielectrics, molecular polarisability, electrostatic energy in dielectric media. Biot and Savart's law, The differential equation of Magnetostatics and Ampere's law, vector potential and magnetic fields of a localised current distribution, Magnetic moment, force and torque on a magnetic dipole in an external field, Magnetic materials, Magnetisation and microscopic equations.

UNIT-II

Time-varying fields& Electromagnetic Waves: Time varying fields, Maxwell's equations, conservation laws, Faraday's law of induction, Energy in a magnetic field. Maxwell's displacement current, vector and scalar potential, Gauge transformations; Lorentz gauge and Coulomb gauge, Poynting theorem, conservation laws for a system of charged particles and electromagnetic field, continuity equation. Plane wave like solutions of the Maxwell equations. Polarisation, linear and circular polarization. Superposition of waves in one dimension. Group velocity. Illustration of propagation of a pulse in dispersive medium. Reflection and refraction of electromagnetic waves at a plane surface between dielectrics. Polarization by reflection and total internal reflection. Waves in conductive medium, simple model for conductivity.

UNIT-III

Wave Guides & Relativistic formulation of electrodynamics: Field at the surface of and within a conductor. Cylindrical cavities and wave-guides, modes in a rectangular wave guide, energy flow and attenuation in wave guides. Perturbation of boundary conditions, resonant cavities, power loss in cavity and quality factor, Special theory of relativity, simultaneity, length, contraction, time dilation and Lorenz's transformations. Structure of space-time, four scalars, four vectors and tensors, Magnetism as a relativistic phenomena and field transformations. Recasting Maxwell equations in the language of special relativity, covariance and manifest covariance, field tensor. Lagrangian formulation for the covariant Maxwell equations.

UNIT-IV

Radiation Systems& Fields of moving charges: Fields of radiation of localized oscillating sources, electric dipole fields and radiation, magnetic dipole and electric quadrupole fields, central fed antenna, brief introduction to radiation damping and radiation reaction. Lienard Wiechert potential, field of a moving charge. Radiated power from an accelerated charge at low velocities, Larmour's power formula and its relativistic generalisation ; Angular distribution of radiation emitted by an accelerated charge.

Text and Reference Books:

S. No.	Name	Author(S)	Publisher
1	Classical Electrodynamics	J.D. Jackson	John &Wiley Sons Pvt. Ltd. New York, 2004
2	Introduction to Electrodynamics	D.J. Griffiths	Pearson Education Ltd., New Delhi
3	Classical Electromagnetic Radiation	J.B. Marion	Academic Press, New Delhi, 1995.

Course Code	**PHY554**
Course Title	**Condensed Matter Physics**
Type Course	Major
L T P	4 0 0
Credits	4
Course Prerequisite	B.Sc. with physics as one of major subjects
Course Objective	The main objectives of the course are to provide understanding of the enormously rich behavior of condensed matter systems under a wide variety of conditions.
Course Outcomes(CO)	**Students will able:** CO1: To understand the classification of magnetic materials &phenomena of superconductivity. CO2: To gain the understanding of the defects in solids & lattice vibrations. CO3: To describe the Lattice Specific & Free electron theory in detail. CO4: To gain understanding of the lattice vibration and dielectrics.

UNIT-I

Classification of magnetic materials & Superconductivity: Classification of magnetic materials, the origin of permanent magnetic dipoles, diamagnetic susceptibility, classical theory of para magnetism, Quantum theory of paramagnetism, Quenching of orbital angular momentum, cooling by adiabatic demagnetization. Paramagnetic susceptibility of conduction electrons. Ferromagnetism, the Weiss molecular field, the interpretation of the Weiss field. Ferromagnetic domains, Spin waves, quantization of spin waves, Thermal excitations of magnons. The two sub-lattice model, super exchange interaction, the structure of ferrites, saturation magnetisation, Neel's theory of ferrimagnetism, Curie temperature and susceptibility of ferrimagnets. General properties of ferroelectric materials. The dipole theory of ferroelectricity, objection against dipole theory, Thermodynamics of ferroelectric transitions

Superconductivity, zero resistivity, critical temperature, Meissner effect, Type I and Type II superconductors, specific heat and thermal conductivity, BCS theory, Ginzsburg-Landou theory, Josephson effect: dc Josephson effect, ac Josephson effect, macroscopic quantum interference, high temperature superconductivity.

UNIT-II

Defects in Solids & Lattice Vibrations: Point defects: Impurities, Vacancies- Schottky and Frankel vacancies, Color centers and coloration of crystals, F-centres, Line defects (dislocations), Edge and screw dislocations, Berger Vector, Planar (stacking) Faults, Grain boundaries, Low angle grain boundaries, the Hydration energy of ions, Activation energy for formation of defects in ionic crystals, Ionic conductivity in pure alkali halides. Vibrations of one dimensional linear monoatomic lattice, Normal modes of vibrations in a finite length of the lattice, The linear diatomic lattice, Excitation of optical branch in ionic crystals – the infra red absorption, Quantization of lattice vibrations – concept of phonons, Phonon momentum, In elastic scattering of photons by phonons, Inelastic scattering of neutrons by phonons.

UNIT-III

Lattice Specific & Free electron theory: The various theories of lattice specific heat of solids. Einstein model of the Lattice Specific heat. Density of modes of vibration, Debye model of Lattice specific heat, Born cut-off procedure, specific heat of metals, Elastic strain and stress component. Elastic compliance and stiffness constants. Elastic constants of cubic crystals. Elastic waves in cubic crystals. Band theory, Electrical conductivity of metals, Drift velocity and relaxation time, the Boltzmann transport equation. The Sommerfield theory of conductivity, Mean free path in metals, qualitative discussion of the features of the resistivity, Mathiesson's rule Luminescence, excitation and emission, Decay mechanisms, Thallium activated alkali halides. The Sulphide phosphors. Electro-Luminescence.

UNIT-IV

Polaritons and Dielectrics: Dielectric function of the electron gas, plasma optics, transverse and longitudinal modes in plasma, plasmons. Electrostatic screening, polaritons and LST relations, Electron- phonon interaction, polarons, Kramer-Kroning relations, Conductivity of collissionless electrons. Macroscopic field, The local field, Lorentz field. The Claussius-Mossotti relations, Different contribution to polarization: dipolar, electronic and ionic polarizabilities,

Text and Reference Books:

S.No.	**Name**	**Author(S)**	**Publisher**
1	An Introduction to Solid State Physics	C. Kittel	Wiely Estem Ltd., New Delhi, 1979
2	Solid State Physics	A.J. Dekkar	Maemillan India Ltd., New Delhi, 2004
3	Principles of Solid State Physics	R.A. Levy	New York Academy, 196

Course Code	**PHY556**
Course Title	**Atomic & Molecular Spectroscopy**
Type of Course	Major
L T P	4 0 0
Credits	4
Course Prerequisite	B.Sc. with physics as one of major subjects
Course Objectives	This course will enhance the learning of students in the field of atomic and molecular structure, understand the different Spectroscopic techniques and its application.
Course Outcomes(CO)	**Students will able:** CO1: To describe the atomic spectra of one and two valence electron atoms. CO2: To explain the change in behavior of atoms in external applied electric and magnetic field. CO3: To apply their knowledge of quantum mechanical concepts to describe atomic and molecular spectra in details. CO4: To understand the importance and practical application of spectroscopy in modern research.

UNIT-I

Spectra of one and two valence electron systems: Magnetic dipole moments; Larmor's theorem; Space quantization of orbital, spin and total angular momenta; Vector model for one and two valence electron atoms; Spin-orbit interaction and fine structure of hydrogen, Lamb shift, Spectroscopic terminology; Spectroscopic notations for L-S and J-J couplings; Spectra of alkali and alkaline earth metals; Interaction energy in L-S and J-J coupling for two electron systems; Selection and Intensity rules for doublets and triplets.

UNIT-II

Breadth of spectral line and effects of external fields: The Doppler effect; Natural breadth from classical theory; natural breadth and quantum mechanics; External effects like collision damping, asymmetry and pressure shift and stark broadening; The Zeeman Effect for two electron systems; Intensity rules for the Zeeman effect; The calculations of Zeeman patterns; Paschen-Back effect; LS coupling and Paschen –Back effect; Lande's factor in LS coupling; Stark effect.

UNIT-III

Microwave and Infra-Red Spectroscopy: Types of molecules, Rotational spectra of diatomic molecules as a rigid and non-rigid rotator, Intensity of rotational lines, Effect of isotopic substitution, The vibrating diatomic molecule as a simple harmonic and anharmonic oscillator, Diatomic vibrating rotator, The vibration-rotation spectrum of carbon monoxide, The interaction of rotation and vibrations, Fourier transform spectroscopy.

UNIT-IV

Raman and Electronic Spectroscopy: Quantum and classical theories of Raman Effect, Pure rotational Raman spectra for linear and polyatomic molecules, Vibrational Raman spectra, Structure determination from Raman and infra-red spectroscopy, Electronic structure of diatomic molecule, Electronic spectra of diatomic molecules, Born Oppenheimer approximation-The Franck-Condon principle, Dissociation and pre-dissociation energy, The Fortrat diagram, example of spectrum of molecular hydrogen.

Text and Reference Books:

S.No.	Name	Author(S)	Publisher
1	Fundamentals of Molecular spectroscopy	C.N. Banwell and Elaine M. McCash	Tata Mc Graw Hill, 1986
2	Spectroscopy Vol. I, II & III	Walker & Straughe	Springer

Course Code	**PHY560**
Course Title	**Statistical Mechanics**
Type of course	Major(DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	The objective of this course is to explain and predict the macroscopic properties of matter by statistically analyzing the microscopic behavior of its constituent particles.
Course Outcomes (CO)	**Students will able:** CO1: To identify the link between statistics and thermodynamics, classical and quantum statistics and its applications. CO2: To describe the fundamentals of classical statistical mechanics and learn about phase space, various ensembles and their application in some cases. CO3: To learn about the quantum mechanical theory of statistics and its application in various important cases of Bosons and Fermions. CO4: To understand the behaviour of ideal Bose and Fermi gases.

UNIT-I

Classical Stat. Mech. I: Foundation of statistical mechanics; specification of states in a system, contact between statistics and thermodynamics, the classical ideal state, the entropy of mixing Gibbs paradox, The phase space of classical systems, Liouville's theorem and its consequences.

UNIT-II

Classical Stat. Mech. II: The microcanonical ensemble with examples. The canonical ensemble and its thermodynamics, partition function, classical ideal gas in canonical ensemble theory, energy fluctuations in the canonical ensemble. A system of harmonic oscillators. The statistics of paramagnetism. The grand canonoonical ensemble, the physical significance of the statistical quantities, examples, fluctuation of energy and density. Cluster expansion of classical gas, the virial equation of state.

UNIT-III

Quantum Stat. Mech.I : Quantum states and phase space, the density matrix, statistics of various ensembles. Example of electrons in a magnetic field, a free particle in a box and a linear harmonic oscillator. Significance of Boltzmann formula in classical and quantum statistical mechanics.

UNIT-IV

Quantum Stat. Mech. II: An ideal gas in quantum mechanical microcanonical ensemble. Statistics of occupation numbers, concepts and thermodynamical behavior of an ideal gas. Bose Einstein condensation, Discussion of a gas of photons and phonons, Thermodynamical behavior of an ideal Fermi gas, electron gas in metals, Pauli paramagnetism, and statistical equilibrium of white dwarf stars.

Text and Reference Books:

S. No	Name	Author(S)	Publisher
1	Statistical Mechanics	R.K. Patharia	Butten Worth Heinemann, 1996
2	Statistical and Thermal Physics	F. Reif	Mc-Graw Hill, 1965
3	Statistical Mechanics	Kerson Huang	Wiley, 1963

Course Code	**PHY562**
Course Title	**Instrumentation and Experiment Design**
Type of course	Major(DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	The objective of Instrumentation and Experiment Design is to develop accurate, reliable, and efficient measurement systems and methodologies for acquiring, analyzing, and interpreting data to test scientific hypotheses or validate engineering processes.
Course Outcomes (CO)	**Students will able:** CO1: to analyze and fit the experimental data and different kind of errors coming in data will also be analyzed CO2: explain principle, theory and application of various sensors and transducers. CO3: explain the basic principle and importance of the different AC and DC measurement techniques CO4: explain the concepts of signal conditioning and noise analysis

UNIT-I

Data Interpretation and Analysis: Precision and accuracy, Errors in measurements: Statistical and systematic, Error analysis, Propagation of errors. Frequency distributions, Probability distributions: mean and variance, Probability densities: Normal distribution, Log Normal distributions. Curve Fitting: least square method, Linear and non linear, Chi-square test.

UNIT-II

Transducers: Sensors and Transducers: Temperature, Pressure, Vibration, Magnetic Field, Force and Torque, Optical.

UNIT- III

Measurements: Resistance: DC Measurements: Wheatstone bridge, The Kelvin Bridge, Potentiometers, AC Measurements: Inductor and capacitor equivalent circuits, AC operation of a Wheatstone bridge, Capacitance Measurement: The resistance ratio bridge, The De Sauty Bridge, Wein Bridge. Inductance Measurement: The Maxwell Bridge, Parallel Inductance bridge, Anderson bridge. Voltage Measurement: AC and DC, Current Measurement: AC and DC. Resistivity Measurement: 2-probe, 4-probe and Van-der-Paw measurements.

UNIT- IV

Signal Conditioning and Noise: Signal Conditioning, Analog signal conditioning: Operational amplifiers, Instrumentational amplifiers, precision absolute value circuits, True RMS to DC converters. Phase sensitive detection: Lock in amplifier, Box-car integrator, Spectrum analyzer. Noise in Circuits: Probability Density Functions, The Power Density Spectrum, Sources of noise, Noise limited resolution of Op-amp, minimum resolvable DC current, Coherent interference and its sources, Ground loops and their prevention. Introduction to Digital signal conditioning. The Fast Fourier Transformer, Sampling time and Aliasing, Voltage and Current sources.

Text and Reference Books:

S. No	Name	Author(S)	Publisher
1	Measurement, Instrumentation and Experiment Design in Physics and Engineering	Sayer, M., Mansingh, A.	Prentice Hall of India (2000).
2	Introduction to Instrumentation and Measurements	Northrop, Robert, B.,	CRC, Taylor & Frances (2005)
3	Transducers and instrumentation	Murthy, D.V.S.,	Prentice Hall of India (2008)
4	Probability and Statistics for Engineers	Johnson, Richard A., Miller and Freund's	Dorling Kingsley (2005)
5	The Art of Electronics	Horowitz P. and Hill, W.,	Cambridge University Press (2006)
6	Modern Electronic Instrumentation and Measurement Techniques	Helfrick, A.D., Cooper, W.D.,	Prentice Hall of India (2007)

Course Code	**PHY564**
Course Title	**Fabrication of Electronic Devices**
Type of course	Major(DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	This course will enhance the students with employability skill &industrial skill for fabricating electronic devices.
Course Outcomes (CO)	**Students will able:** **CO1:** To explain the physics of crystal growth & can apply to fabricate electronic devices. **CO2:** To understand the role of diffusion in fabricating electronic devices. **CO3:** Apply the knowledge of interconnections (metallic) to fabricate electronic circuits. **CO4:** Apply optical lithography to design electronic devices.

UNIT- I

Crystal Growth: Czochralski and Bridgman techniques, Float Zone growth, Distribution coefficients, Zone refining, Wafer preparation and specifications. Epitaxy: importance of lattice matching in epitaxy, CVD of Si, Thermodynamics of vapour phase growth, defects in epitaxial growth, MBE technology.

UNIT- II

Diffusion: Fick's diffusion equation in one dimension, Atomistic models of diffusion, analytic solution of Fick' s law for different cases. Diffusivities of common dopants in Si and SiO2. Diffusion enhancements and retardation, Thermal Oxidation: Deal-Grove model of oxidation. Effects of dopants during oxidation, oxidation induced defects, Ion Implantation: channeling and projected range of ions, implantation damage, Rapid Thermal Annealing (RTA).

UNIT- III

Metallization Applications: Gates and interconnections, Metallization choices, metals, alloys and silicides, deposition techniques, metallization problems, step coverage, electro migration, Etching: Dry and wet chemical etching, Reactive Plasma Etching, Ion enhanced etching and ion induced etching.

UNIT- IV

Optical Lithography: photo resists, Contact and proximity printers, projection printers, Mask alignment, X-ray and electron beam lithography, Fundamental considerations for IC processing: Building individual layers, Junction and Trench isolation of devices.

Text and Reference Books:

S. No	Name	Author(S)	Publisher
1	The Science and Engineering of Microelectronics Fabrication	SA Campbell	Oxford University Press –1996
2	VLSI Technology	SM Sze	McGraw Hill International Editions – 1988
3	Fundamentals of Microelectronics Processing	HH Lee	Mc Graw Hill – 1990
4.	The Theory and Practice of Microelectronics	SK Gandhi	John Wiley & Sons 1968
5.	Silicon VLSI Technology: Fundamentals, Practice and Modeling	James D. Plummer, Michael D. Deal, Peter B. Griffin	Prentice Hall- 2000

Course Code	**PHY558**
Course Title	**Nuclear &Particle Physics**
Type of course	Minor
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	The objective of this course is to introduce students to the fundamental principles and concepts governing nuclear physics.
Course Outcomes (CO)	**Students will able:** CO1: To understand the concept of nuclear interactions & nuclear model. CO2: To learn about the nuclear decays like α-decay, beta decays , gamma decay & nuclear reactions and their properties like Compound nuclear-scattering matrix, Resonance scattering. CO3: To describe the Elementary Particles, Symmetries and their Conservation Laws. CO4: To describe the weak interactions including, V-A weak interaction theory Gauge theory and Cabbibo theorem

UNIT-I

Nuclear Interactions and Nuclear Models: Deuteron problem, pp and pn scattering experiments at low energy, meson theory of nuclear forces, e.g. Bartlett, Heisenberg, Majorans forces, exchanges forces and tensor forces, effective range theory-spin dependence of nuclear forces-Charge independence and charge symmetry of nuclear forces, Isospin formalism, Liquid drop model, Bohr-Wheeler theory of fission, Shell model, Collective model, Nilsson model.

UNIT-II

Nuclear Decay& Nuclear Reactions: Beta decay, Fermi theory of beta decay, Angular momentum and parity selection rules, Comparative half-lives, Allowed and forbidden transitions selection rules, parity violation, Detection and properties of neutrino, Gamma decay, Multipole transitions in nuclei, Angular momentum and parity selection rules, Internal conversion, Nuclear isomerism, Direct and compound nuclear reaction mechanisms, cross sections in terms of partial wave amplitudes, Compound nucleus, scattering matrix, Reciprocity theorem, Breit Winger one level formula, Resonance scattering.

UNIT-III

Elementary Particles, Symmetries and Conservation Laws: Historical survey of elementary particles and their classification, Conserved quantities and symmetries, the electric charge, baryon number, leptons and muon number, particles and antiparticles, hypercharge (strangeness), the nucleon isospin, isospin invariance, isospin of particles, parity operation, charge conservation, time reversal invariance, CP violation and CPT theorem, the KO – KO doublet unitary symmetry SU(2), SU (3) and the quark model.

UNIT-IV

Weak Interaction& Gauge theory: Classification of weak interactions, Parity non conservation in beta decay, lepton polarization in beta decay, the V-A interaction. Weak decays of strange-particles and Cabibbo's theory. Gauge symmetry, field equations for scalar (spin 0), spinor (spin ½), vector (spin-1) and fields, global gauge invariance, local gauge invariance, Feynmann rules, introduction of neutral currents. Spontaneously broken symmetries in the field theory, standard model.

Text and Reference Books:

S. No	Name	Author(S)	Publisher
1	Nuclear Structure, Vol.1(1969) and Vol.2	A. Bohr and B.R. Mottelson	Pearson
2	Introductory Nuclear Physics	Kenneth S. Krane	Wiley, New York, 1988
3	Atomic and Nuclear Physics Vol.2	G.N. Ghoshal	S. Chand and Co., 1997
4	Subatomic Physics	H. Fraunfelder and E.M. Henley	N.J. Prentice Hall
5	Introduction to Elementary Particles	D. Griffiths	Wiley-VCH-2008
6	Introduction to High Energy Physics	D.H Perkins	Cambridge University Press, 2000

Course Code	**CHM580**
Course Title	**Structures, Spectra and Properties of Biomolecules**
Type of course	MDC
L T P	3 0 0
Credits	3
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	The course is to impart the knowledge of biomolecules in detail
Course Outcomes (CO)	**Students will able:** CO1: To understand structure aspects of biomolecule. CO2: To know the theoretical techniques and their application to biomolecules. CO3: To understand spectroscopic techniques and their application to biomolecule. CO4: To explain structure-function relationship & modeling in biomolecule

UNIT- I

Structure Aspects of Biomolecule: Conformational Principles, Conformation and Configuration Isomers and Derivatives of biomolecules, Structure and properties of amino acids, Structure of Polypeptides, Primary, Secondary, Tertiary and Quaternary Structure of Proteins.

UNIT- II

Conformational study of carbohydrates, Structure of Polysaccharides. Structure of Polynucleotides, DNA, RNA, **Theoretical Techniques and Their Application to Biomolecules:** Hard Sphere Approximation, Conformational properties of polypeptides and Ramachandran plot,

UNIT- III

Spectroscopic Techniques and their Application to Biomolecules: Absorption and Fluorescence Spectroscopy (UV-VIS spectroscopy), Circular Dichroism, Laser Electrophoresis, Raman Spectroscopy, IR spectroscopy, Use of NMR in Elucidation of Molecular Structure, Photoacoustic Spectroscopy, Photo-biological Aspects of Nucleic Acids.

UNIT- IV

Structure-Function Relationship and Modeling: Molecular Recognition, Hydrogen Bonding, Drug-Receptor interactions, Lipophilic Pockets on Receptors, Drugs and Their Principles of Action, Lock and Key Model and Induced fit Model.

Text and Reference Books:

S. No	Name	Author(S)	Publisher
1	Conformations of Biological Molecules	Govil & Hosur	Pearson
2	Basic Molecular Biology	Pullman	Indian Publishing house
3	Biological Chemistry	Mehler&Cordes	Pearson
4	Structure Aspects of Biomolecules	Srinivasan & Pattabhi	John &Wiely

5	Organic Chemistry, 5th Edition	Paula Yurkanis Bruice	Pearson
6	An Introduction to medicinal Chemistry	Graham L Patrick	Oxford

Course Code	**PHY568**
Course Title	**Condensed Matter Physics Lab**
Type of course	Major
L T P	0 0 4
Credits	2
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	The course is to impart practical knowledge to the students about the measurement of different physical properties (electric, magnetic, dielectrics etc.) using different methods.
Course Outcomes (CO)	**Students will able:** CO1: To study the band gap, magneto resistance, resistivity and charge carrier concentration in semiconductors. CO2: To know how to determine the crystal structure, lattice parameter and crystallite size? CO3: To understand measurement and analysis of various types of transport. CO4: To explain optical characterization of solid, magnetic and dielectric behavior of solids.

***Note: Students has to do 6 experiments from each of the section given below.**

Semiconductor:
1. To determine Hall coefficient by Hall Effect.
2. To determine the band gap of a semiconductor using p-n junction diode.
3. To determine the energy gap and resistivity of the semiconductor using four probe method.
4. To study temperature-dependence of conductivity of a given semiconductor crystallizing four probe method.
5. To study the characteristics of a PN junction with varying temperature & the capacitance of the junction.
6. To find magneto resistance of semiconductor.
7. To measure magneto resistance of a thin (0.5 mm) sample of p-doped (or n-doped) germanium as a function of magnetic field for 3 different sample current.

Magnetic effects & dielectrics:
1. To determine the magnetic susceptibility of a material using Quink's method.
2. To determine the g-factor using ESR spectrometer.
3. To trace hysteresis loop and calculate retentivity, coercivity and saturation magnetization.
4. To determine dielectric constant.
5. To study the series and parallel characteristics of a photovoltaic cell.
6. To study the spectral characteristics of a photovoltaic cell.

Text and Reference Books

S. No	Name	Author(S)	Publisher
1	Practical Physics	C. L. Arora	S. Chand
2	Advanced Practical Physics for students	B.L.Flint and H.T.Worsnop	1971, Asia Publishing House
3	Engineering Practical Physics	S.Panigrahi & B.Mallick	Cengage Learning

			India Pvt. Ltd. 2015
4.	A Text Book of Practical Physics	Indu Prakash and Ramakrishna	11th Edition, 2011, Kitab Mahal, New Delhi.
5.	Advanced level Physics Practicals	Michael Nelson and Jon M. Ogborn,	4th Edition, reprinted 1985, Heinemann Educational Publishers.

Course Code	**PHY570**
Course Title	**Atomic & Molecular Spectroscopy Lab**
Type of course	Major
L T P	0 0 4
Credits	2
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	The purpose of this lab is to understand of atomic structure and its relation to the production of light.
Course Outcomes (CO)	**Students will able:** CO1: To study the spectroscopic behavior of materials. CO2: To understand nature of atomic energy levels. CO3: To gain understanding of the wave nature of light along with the measurement of the wavelength of the light. CO4: To learn the impact of the external magnetic field on the atomic energy levels.

***Note: Perform atleast two experiments from each section**.

(A) Optics:

1. To find the wavelength of monochromatic light using Fabry Perot interferometer.
2. To find the wavelength of sodium light using Michelson interferometer.
3. To find the wavelength of He-Ne laser using double slit interference pattern.
4. To study Faraday Effect using He-Ne Laser.

(B) Spectrometer:

1. To calibrate the constant deviation spectrometer with white light and to find the wavelength of unknown monochromatic light.
2. To find the resolving power and to determine angle of the given prism.
3. To determine Cauchy's constant of the given prism.
4. To determine the refractive index and dispersive power of prism.
5. Determination of Lande's g factor of DPPH using Electron-Spin resonance (E.S.R.) Spectrometer.

(C) Diffraction:

1. To find the grating element of the given grating using He-Ne laser light.
2. To determine the number of lines per millimeter of the grating using the green line of the mercury spectrum.
3. To calculate the wavelength of the other prominent lines of mercury by normal incidence method.

(D) Measurement of e/m and electronic charge:

1. To verify the existence of Bohr's energy levels with Franck-Hertz experiment.
2. To determine the charge to mass ratio of an electron with normal Zeeman effect.

(E) Ultrasonics:

1. To determine the velocity of ultrasonic waves in a given liquid using ultrasonic interferometer.
2. To calculate the adiabatic compressibility of a given liquid using ultrasonic interferometer.

Text and Reference Books

S. No	Name	Author(S)	Publisher
1	Practical Physics	C. L. Arora	S. Chand
2	Advanced Practical Physics for students	B.L.Flint and H.T.Worsnop	1971, Asia Publishing House
3	Engineering Practical Physics	S.Panigrahi & B.Mallick	Cengage Learning India Pvt. Ltd. 2015
4.	A Text Book of Practical Physics	Indu Prakash and Ramakrishna	11th Edition, 2011, Kitab Mahal, New Delhi.
5.	Advanced level Physics Practicals	Michael Nelson and Jon M. Ogborn,	4th Edition, reprinted 1985, Heinemann Educational Publishers.

SEMESTER III

Course Code	**RM653**
Course Title	**Basics of Research Methodology in Physical and Mathematical Sciences**
Type of course	Major
L T P	4 1 0
Credits	5
Course prerequisite	B. Sc. Medical or Non-medical
Course Objective	To understand the philosophy of research and ethics, research integrity and publication ethics. To identify research misconduct and predatory publications. To understand indexing and citation databases, open access publications, research metrics (citations, h-index, impact Factor, etc.). To understand the usage of plagiarism tools
Course outcomes (CO)	**Students will able:** CO1: To understand some basic concepts of research and its methodologies. CO2: To identify appropriate research topics. . CO3: To select and define appropriate research problem and parameters.

UNIT-I

Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process.

UNIT-II

Problem Identification & Formulation: Research Question, Investigation Question, Measurement Issues, Hypothesis, Qualities of a good Hypothesis, Null Hypothesis & Alternative Hypothesis. Hypothesis Testing, Logic & Importance. Methods of Data Collection: Collection of Primary Data –secondary data, Drafting Questionnaire-Data Collection through Questionnaire - Data Collection through Schedules, Collection of Secondary Data.

UNIT-III

Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.

UNIT-IV

Qualitative and Quantitative Research: Qualitative research – Quantitative research – Concept of measurement, causality, generalization, replication. Merging the two approaches. Measurement: Concept of measurement– what is measured? Problems in measurement in research – Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval, Ratio.

Text and Reference books:

S.No.	**Name/Title**	**Author**	**Publisher**
1	Research Methodology: Methods & Techniques (Rev. Ed.)	C.R. Kothari	New Age International. New Delhi
2	Business Research Methods	Alan Bryman & Emma Bell	Oxford University Press
3	Research Methodology	Sinha, S.C. and Dhiman, A.K.	ESS ESS Publications
4	An Introduction to Research Methodology	B.L. Garg, R. Karadia, R., F. Agarwal, F. and	RBSA Publishers

		U.K. Agarwal	

Course Code	**PHY651**
Course Title	**Nanotechnology**
Type of course	Major(DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	The primary aim is to prepare students for a career in nanotechnology by providing them with a sound grounding in multidisciplinary area of nanoscale science.
Course Outcomes (CO)	**Students will able:** CO1: To understand different methods involved in synthesis nanomaterials. CO2: To determine the basic properties of nanoparticles using different characterization techniques. CO3: To understand the physics of carbon nano tubes, fullerenes, graphene involving their synthesis and applications. CO4: To gain basic knowledge of nanosemiconductors devices, nanosensors and their applications in different areas.

UNIT-I

Introduction and Synthesis of Nano Materials: Basic idea of nanotechnology, nano materials, nanoparticles.

Physical Techniques of Fabrication: inert gas condensation, Arc Discharge, RF plasma, Ball milling, Molecular Beam Epitaxy, Chemical Vapour deposition, Electrodeposition,

Chemical Methods: Metal nanocrystals by reduction, photochemical synthesis, electrochemical synthesis, Sol-gel.

Lithographic Techniques: AFM based nanolithography and nanomanipulation, E-beam lithography and SEM based nanolithography, X ray based lithography.

UNIT-II

Characterization Techniques: X-ray diffraction, data manipulation of diffracted X-rays for structure determination, Scanning Probe microscopy, Scanning Electron microscopy, Transmission Electron Microscopy, Scanning Tunneling Microscopy, Optical microscopy, FTIR Spectroscopy, Raman Spectroscopy, DTA, TGA and DSC measurements.

UNIT-III

Carbon Nanotubes and other Carbon based materials: Preparation of Carbon nano tubes, Properties of CNT (Electrical, Optical, Mechanical, Vibrational properties), Application of CNT (Field emission, Fuel Cells, Display devices).

Carbon based materials: Preparation of Fullerene, Graphene preparation, characterization and properties, DLC and nanodiamonds.

UNIT-IV

Nanosemiconductors and Nano sensors: Semiconductor nanoparticles, optical luminescence and fluorescence from direct band gap semiconductor nanoparticles, carrier injection, polymers-nanoparticles, LED and solar cells, electroluminescence. Fundamentals of sensors, Micro Nanosensors and biosensor, MEMS and NEMS, packaging and characterization of sensors.

Text and Reference Books:

S. No	Name	Author(S)	Publisher
1	Introduction to nanoscience and Nanotechnology	K.K. Chattopadhyay and A.N. Banerjee	PHI Learning Pvt. Ltd. 2009
2	Nanotechnology Fundamentals and Applications	Manasi Karkare,	I.K.- International Publishing House, 2008.
3	Nanostructures and Nanomaterials Synthesis, Properties and Applications	Guoahong Cao	Imperial College Press, 2004
4	Physical Properties of Carbon Nanotube	D. Satio, G. Dresselhaus and M. S. Dresselhaus	Imperial College Press, 1998

Course Code	**PHY653**
Course Title	**Physics of Nanomaterials**
Type of course	Major(DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	The objective of this course is to introduce students to the basic physics of Nano materials and latest advance in it.
Course Outcomes (CO)	**Students will able:** CO1: To develop fundamental knowledge of nanomaterials. CO2: To correlate the properties of nano structures with their size, shape and surface characteristics. CO3: To explain the effects of quantum confinement on the electronic structure & corresponding physical and chemical properties of materials at nanoscale. CO4: To understand the physics of carbon nano tubes involving their synthesis and applications in different areas.

UNIT-I

Free electron theory and its features: Idea of band structure of metals, insulators and semiconductors. Density of state in one, two and three dimensional bands and its variation with energy, Effect of crystal size on density of states and band gap, Examples of nanomaterials. Top-down and bottom-up approaches, Physical and chemical methods for the synthesis of nanomaterials with examples.

UNIT-II

Determination of particle size: Determination of particle size and study of texture and microstructure, Increase in x-ray diffraction peaks of nanoparticles, shift in photoluminescence peaks, variation in Raman spectra of nanomaterials, photoemission and X-ray spectroscopy, magnetic resonance, microscopy: transmission electron microscopy, scanning probe microscopy.

UNIT-III

Introduction to quantum wells wires and dots: preparation using lithography; Size and dimensionality effects: size effects, conduction electrons and dimensionality, potential wells, partial confinement, properties dependent on density of states, surface passivation and core/shell nanoparticles, Nanostructured semiconductors and films, single electron tunneling; Application: Infrared detectors, Quantum dot Lasers.

UNIT-IV

Carbon molecules: nature of carbon bond; new carbon structures; Carbon clusters: small carbon clusters, structure of C60, alkali doped C60; Carbon nanotubes and nanofibres: fabrication, structure, electrical properties, vibrational properties, mechanical properties, Application of carbon nanotubes: field emission and shielding, fuel cells, chemical sensors, catalysis.

Text and Reference Books:

S. No	Name	Author(S)	Publisher
1	Introduction to Nanotechnology	Charles P. Poole Jr. and Franks J. Qwens	John Wiley & Sons, 2006
2	Quantum Dot Heterostructures	D. Bimerg, M. Grundmann and N.N. Ledentsov	John Wiley & Sons, 1989

3	Physics of Semiconductor Nanostructures.	K.P. Jain (Narosa),	Wiley, 1997

Course Code	**PHY655**
Course Title	**Spintronics**
Type of course	Major(DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	The objective of the course is to give flavor to the students how spintronics can be used over the present electronics.
Course Outcomes (CO)	**Students will able:** CO1: To study the optical properties & various types of spintronics-based devices. CO2: To understand the theory of charge and spin in quantum dots. CO3: To understand about spin based transport in the device. CO4: To understand magnetic dynamics and application of spin transfer torque.

UNIT-I

Optical properties of III-V-based MAS: Hole-mediated ferromagnetism, Optical properties, Photo induced ferromagnetism, Photo-induced magnetization rotation effect of spin injection, Spin dynamics, Magnetization reversal by electrical spin injection, Circularly polarized light emitters and detectors, Bipolar spintronics, Concept of spin polarization, Optical spin orientation, Spin injection in metallic F/N junctions, Spin relaxation in semiconductors, Bipolar spin-polarized transport and applications, Magnetic p-n junctions.

UNIT-II

Charge and spin in single quantum dots: Constant interaction model, Spin and exchange effect, Controlling spin states in single quantum dots, Charge and spin in double quantum dots Hydrogen molecule model, Stability diagram of charge states, Spin relaxation in quantum dots, Spin blockade in single-electron tunneling, Co-tunneling and the Kondo effect.

UNIT-III

Single-electron transport: Model Hamiltonian, Metallic or ferromagnetic island, Quantum dot Transport regimes, Weak coupling, Quantum dots, Non-Collinear geometry, Ferromagnetic islands, Metallic islands and Shot noise, Co-tunneling, Strong coupling – Kondo effect, RKKY interaction between quantum dots.

UNIT-IV

Spin-transfer torques: Intuitive picture of spin-transfer torques, two magnetic layers, Spin-transfer-driven magnetic dynamics, Applications of spin transfer torques, Electrons in micro- and nanomagnets, Micron-scale magnets and Coulomb blockade, Ferromagnetic nanoparticles, Magnetic molecules and the Kondo effect, Magnetic tunnel junctions, Tunnel-based spin injectors, Spin-Hall effect.

Text and Reference Books:

S. No	Name	Author(S)	Publisher
1	Concepts in Spin Electronics	Sadamichi Maekawa	Oxford Univeristy Press
2	Spintronics	Tomasz Dieti, David D Awshalom	Elsevier

3	Nanomagnetism and Spintronics: Fabrication Materials, Characterization and Application	Farzad Nasirpouri, Alain Nogaret	World Scientific

Course Code	**PHY657**
Course Title	**Theoretical Aspects of Nuclear Structure Physics**
Type of course	Major(DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	This subject would enhance the knowledge of nuclear structure physics to students.
Course Outcomes (CO)	**Students will able:** CO1: To explain nuclear deformation and related orientation effects. CO2: To understand collective description of nuclear behavior. CO3: To examine dynamics of heavy-ion reactions. CO4: To basic aspects of astrophysics.

UNIT-I

Nuclear deformations: Effect of quadrupole deformations and higher multipole deformations, Nuclear orientation effect, deformed magic shells and related nuclear aspects, Importance of Exotic nuclear systems, halo shapes and bubble effect.

UNIT-II

Collective Model of Nucleus: Collective model Hamiltonian, nuclear wave function for even even nuclei and odd-A nuclei, Rotation-vibrational coupling, Nilsson model, Cranking shell model, IBM model, VMI model, Nuclear softness model, Four parameter, 2&3 parameter formula.

UNIT-III

Heavy-Ion Physics: Total Hamiltonian function, Scattering of deformed nuclei, Fusion fission dynamics, Radioactive ion beams, tightly and loosely bound interactions, Nuclear isomers, Nuclear Molecules, Nuclear Dynamics at Intermediate and high energies, Relativistic heavy ion collisions

UNIT-IV

Nuclear Astrophysics: Hot big bang cosmology, stellar nucleosynthesis, energy production in stars, pp chain, CNO cycle.

Text and Reference Books:

S. No.	**Name**	**Author(S)**	**Publisher**
1	Theory of Nuclear Structure	Pal, M.K	East-West Press Delhi, (1983)
2	Structure of Nucleus	Preston M. A. and Bhaduri R. K	Addison-Wesley, (2000)
3	Nuclear physics principles and applications	Lilley J.S.	John Wiley & sons Ltd., (2007)
4	Nuclear Physics	Krane K.S.	Wiley India Pvt. Ltd., (2008)

Course Code	**PHY659**
Course Title	**Plasma Physics**
Type of course	Major(DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	This subject enhances the knowledge of plasma physics in students.
Course Outcomes (CO)	**Students will able:** CO1: To understand the origin of plasma, conditions of plasma formation and properties of plasma. CO2: To classify propagation of electrostatic and electromagnetic waves in magnetized and non-magnetized plasmas. CO3: To describe the basics of boltzman& vlasvov equations. CO4: To describe the non-linear plasma theories.

UNIT-I

Basics of Plasmas: Occurrence of plasma in nature, definition of plasma, concept of temperature, Debye shielding and plasma parameter, Single particle motion in uniform E and B, non uniform magnetic field, grid B and curvature drifts, invariance of magnetic moment and magnetic mirror.

UNIT-II

Plasma Waves: Plasma oscillations electron plasma waves, ion waves, electrostatic electron and ion oscillations perpendicular to magnetic field upper hybrid waves, lower hybrid waves, ion cyclotron waves, Light waves in plasma.

UNIT-III

Boltzmann and Vlasov Equations: The fokker plank equation, integral expression for collision lern zeroth and first order moments, the single equation relaxation model for collision lern. Application kinetic theory to electron plasma waves, the physics of landau damping, elementary magnetic and inertial fusion concepts.

UNIT-IV

Non-linear Plasma Theories: Non-linear Electrostatic Waves, KdV Equations, Non-linear Schrodinger Equation, Solitons, Shocks, Non-linear Landau Damping.

Text and Reference Books:

S. No.	Name	Author(S)	Publisher
1	Introduction to Plasma Physics and Controlled Fusion	F. F. Chen	Springer, 1984
2	Plasma Physics	R. O. Dendy	Cambridge University Press
3	Ideal Magneto hydrodynamics	J. P. Friedberg	Springer edition, 1987
4	Fundamental of Plasma Physics	S. R. Seshadri	American Elsevier Pub. Co

Course Code	**PHY661**
Course Title	**Radiation Physics**
Type of course	Major(DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	Understand the basic physics of the electromagnetic and particulate forms of ionizing radiation. Understand the distinctions between the units of radiation quantity, exposure and dose. Be familiar with some of the methods used to measure radiation dose.
Course Outcomes (CO)	**Students will able:** CO1: To study nuclear radiation and its radiation quantities. CO2: To understand in detail about different dosimeters. CO3: To study nuclear radiation effects and its detection and protection. CO4: To understand about different radiation shielding.

UNIT-I

Ionizing Radiations and Radiation Quantities: Types and sources of ionizing radiation, fluence, energy fluence, kerma, exposure rate and its measurement - The free air chamber and air wall chamber, Absorbed dose and its measurement , Bragg Gray Principle, Radiation dose units(rem, rad, Gray and sievert), dose commitment, dose equivalent and quality factor.

UNIT-II

Dosimeters: Pocket dosimeter, films, solid state dosimeters such as TLD, SSNTD, chemical detectors and neutron detectors. Simple numerical problems on dose estimation.

UNIT-III

Radiation Effects and Protection: Biological effects of radiation at molecular level, acute and delayed effects, stochastic and non-stochastic effects, Relative Biological Effectiveness (RBE), linear energy transformation (LET), Dose response characteristics. Permissible dose to occupational and non-occupational workers, maximum permissible concentration in air and water, safe handling of radioactive materials, The ALARA, ALI and MIRD concepts, single target, multitarget and multihit theories, Rad waste and its disposal, simple numerical problems.

UNIT-IV

Radiation Shielding: Thermal and biological shields, shielding requirement for medical, industrial and accelerator facilities, shielding materials, radiation attenuation calculations-The point kernal technique, radiation attenuation from a uniform plane source. The exponential point-Kernal. Radiation attenuation from a line and plane source.

Text and Reference Books:

S. No	Name	Author(S)	Publisher
1	Nuclear Reactor Engineering	S. Glasstone and A. Sesonke	Van Nostrand Reinhold
2	Radiation Theory	Alison. P. Casart	
3	Radiation Biology	A. Edward Profio	Radiation Bio/Prentice Hall, 1968

Course Code	**PHY663**
Course Title	**Introduction to NMR Spectroscopy**
Type of course	Major(DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	Understand the basic physics of the NMR Spectroscopy
Course Outcomes (CO)	**Students will able:** CO1: To study basics of quantum physics to have in depth knowledge of NMR. CO2: To understand in detail about ESR, NMR Spectrometer CO3: To study different experimental setup of NMR Spectrometer. CO4: To understand about different applications of NMR.

UNIT-I

Introduction to quantum physics: Stern gerlach experiment, Classical angular momentum, Quantum angular momentum, spin angular momentum, Combining angular momenta, Spin of the nucleus, The Pauli Principle, Nuclie, fundamental particles, Neutrons and protons, Isotop, isobar, isoton, Nuclear spin, Zeeman effect, Spins in the magnetic field, micro magnetism, gyromagnetic ratio of different nucleus, Spin Precession and Larmor Frequency.

UNIT-II

Introduction to ESR, NMR Spectrometer: The Magnet, The Transmitter Section, The Duplexer, probe, Pulsed Field Gradients, receiver section. NMR spectrum, Chemical shift and TMS, Relaxation: T1, T2, Coupled spins.

UNIT-III

A Single-Pulse Experiment, Fourier Transform NMR: NMR Signal and fourier transformed signal, Experiments on Non-Interacting Spins-1/2: 1D expt: Spin echo experiment, T1, T2, PFG-spin echo, 2D Expt: COSY, Hetro nuclear experiments.

UNIT-IV

Applications of NMR: Diffusion study, DOSY, MRI: T1 and T2 weighted MRI, diffusion weighted MRI, Protein structure and chemical structure analysis, Application in drug discovery.

Text and Reference Books:

S. No	Name	Author(S)	Publisher
1	Spin Dynamics, Basics of Nuclear Magnetic Resonance	Malcolm H. Levitt	Pearson
2	Understanding NMR Spectroscopy	James Keeler	John &Wiley
3	Nuclear Magnetic Resonance Basic Principles" by	T I Atta-Ur-Rahman	Jones &John

Course Code	**PHY665**
Course Title	**Fluid Dynamics**
Type of course	Major(DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	Understand the basic of the fluid dynamics.
Course Outcomes (CO)	**Students will able:** CO1: To study fluid flow and understand their basic equations. CO2: To understand in detail about dimensional analysis and dynamics similitude. CO3: To study viscous effect in fluid flow. CO4: To understand about compressible flow.

UNIT-I

Fluid Flow Concepts and Basic equations: Velocity field, acceleration of a fluid element, continuity equation, conservation of momentum, stream line functions, rotation of fluid element, Euler's equation. Bernoulli's equation along a stream line and in rotational flow, Bernoulli's equation from thermodynamics ,static and dynamics pressure, Losses due to geometric changes:-Sudden expansion and contraction Venturimetre.

UNIT-II

Dimensional Analysis and Dynamic Similitude: Buckingham's Π Theorem, Dimensionless parameters, Euler's number, Reynold's number, Froude's number, Weber number, Model studies and wind tunnel tests.

UNIT-III

Viscous Effect: Normal stress shear stress, Navier-Stokes theorem, Flow through a parallel channel,Flow past a sphere, Terminal velocity order of magnitude analysis, Approximation of the Navier-Stokesequations. Boundary layer concepts:-Momentum integral equation, velocity profile, Boundary layer thickness, SkinFriction effecter, Transverse component of velocity, Displacement thickness, momentum thickness.Drag:-Bluff badles, Aerofoil, Boundary layer control, entrance region.

UNIT-IV

Compressible flow: Perfection gas Relations: Speed of propagation in gas, in isothermal and adiabatic condition, Mach number, Limits of incompressibility. Isentropic flow:-Laws of conservation, Static and stagnation values flow through a duct of varying cross-section, mass flow rate, choking a converging passage, constant area adiabatic flow and Fanno like, constant area frictionless flow and Raleigh line. Fluid Metrology: Pressure measurement, Velocity measurement, Turbulence measurement, Viscosity measurement.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Fluid Mechanics	A.K. Mohanty	PHI
2	Fluid Dynamics	R.V. Mises	Springer
3	Foundation of Fluid Mechanics	S. W .Yuan	PHI
4	Text Book of Fluid Mechanics	R. S. Khurmi	S. Chand
5	Perspective in Fluid Dynamics	Batchelor	Cambridge

Course Code	**PHY667**
Course Title	**Instrumental Methods of Analysis**
Type of course	Minor
L T P	2 0 0
Credits	2
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	The objective of this course is to introduce students to the different instrumental techniques in different area of physics.
Course Outcomes (CO)	**Students will able:** CO1: To explain the working principles of the various nuclear detectors. CO2: To understand the techniques involved in the analysis of surface of materials. CO3: To explain the general principle and working of radiation dosimeters. CO4:To understand the working of different techniques of Bio-atmospheric physics.

UNIT-I

Instrumental Techniques for Detection of Nuclear Radiations and their measurements: Ionization chamber, Proportional counter, Geiger-Muller counter, Semiconductor detectors, Scintillation detector, Cherenkov detector. **Accelerators of Charged Particles:** Classification and performance characteristics of accelerators, Electrostatics accelerators, Cyclotron, Synchro-cyclotron, Betatron.

UNIT-II

Techniques for the analysis of surface of the materials: AES, XPS, XAS (X-ray absorption Spectroscopy), X-ray fluorescence spectrometry, EPMA and EDX, Atomic Absorption Spectrometer, Electrons spin resonance, Nuclear magnetic resonance, UV-Vis Spectrometer, FTIR Spectrometer, Raman Spectrometer, SEM, STM,SPM,AFM,TEM.

UNIT-III

Instrumental Techniques in Radiation Physics: Dosimeters: Pocket dosimeter, solid state dosimeters such as TLD, SSNTD, chemical detectors and neutron detectors.

UNIT-IV

Instrumental Techniques and methods in Bio-Atmospheric Physics: Centrifugation (Density Gradient), Chromatography (GC & HPLC), MRI Technique, PET (Positron Emission Tomography) Technique, CT scan (Computed Tomography), Working principle and applications of LIDARS, SODARS, Weather RADARS, Microwave radiometer.

Text and Reference Books:

S. No	Name	Author(S)	Publisher
1	Introductory Nuclear Physics	Kenneth S. Krane	Wiley, New York, 1988
2	Atomic and Nuclear Physics Vol.2	G.N. Ghoshal	S. Chand and Co., 1997

3	An Introduction to Surface Analysis by XPS and AES	John F. Watts and John Wolstenholme	Wiley
4	Nuclear Reactor Engineering	S. Glasstone and A. Sesonke	Van Nostrand Reinhold
5	Radiation Theory	Alison. P. Casart	Wiley
6	Radiation Biology	A. Edward Profio	Radiation Bio/Prentice Hall, 1968
7	Biophysics; An Introduction	Rodney Cotterill,	Wiley, (2014**)**
8	Meteorological Instruments	W.E.K. Middleton and A.F. Spilhaus	Wiley
9	Instruments and Techniques for probing the atmospheric boundary layer	D.H. Lenchow.	Pearson

Course Code	**RM655**
Course Title	**Publication and Research Ethics**
Type of course	Minor
L T P	2 0 0
Credits	2
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	To understand the philosophy of research and ethics, research integrity and publication ethics. To identify research misconduct and predatory publications. To understand indexing and citation databases, open access publications, research metrics (citations, h-index, impact Factor, etc.). To understand the usage of plagiarism tools.
Course Outcomes (CO)	**Students will able:** To have awareness about the publication ethics and publication misconducts

UNIT-I

Introduction to philosophy: Definition, nature and scope, concept, branches - Ethics: definition, moral philosophy, nature of moral judgments and reactions.

UNIT-II

Ethics with respect to science and research: - Intellectual honesty and research integrity - Scientific misconducts: Falsification, Fabrication and Plagiarism (FFP) - Redundant Publications: duplicate and overlapping publications, salami slicing - Selective reporting and misrepresentation of data.

UNIT-III

Publication ethics: Definition, introduction and importance - Best practices / standards setting initiatives and guidelines: COPE, WAME, etc. - Conflicts of interest - Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice versa, types - Violation of publication ethics, authorship and contributor ship - Identification of publication misconduct, complaints and appeals - Predatory publisher and journals.

UNIT-IV

Indexing databases, Citation databases: Web of Science, Scopus, etc. Research Metrics (3 Hrs.): Impact Factor of journal as per Journal Citations Report, SNIP, SJR, IPP, Cite Score - Metrics: h-index, g index, i10 Index, altmetrics.

Text and Reference Books:

S. No	Name	Author(S)	Publisher
1	Thesis and assignment writing	Anderson B. H., Dursaton, and Poole M.	Wiley Eastern 1997
2	Research Design and Methods	Bordens K. S. and Abbott, B	Mc Graw Hill, 2008

3	The Student's Guide to Research Ethics	Paul Oliver	Open University Press, 2003
4	Research Methods – A Process of Inquiry	Graziano, A., M., and Raulin, M. L.	Sixth Edition, Pearson, 2007

Course Code	**PHY669**
Course Title	**Dissertation -I**
Type of course	Major
L T P	0 0 8
Credits	4
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	The dissertation would develop scientific aptitude, reviewing of literature, critical thinking, hypothesis development, experiment planning, synopsis writing, problem presentation and way to solve the problem.
Course Outcomes (CO)	**Students will able:** CO1: To explore research aptitude & practical ability of knowledge gained by student in understanding the basics of research CO2. To develop critical thinking through the detailed review of literature comprehend expertise for writing the research reports in form of review article as well as research publications. CO3. To analyze & generate experimental skills towards the industrial applications. CO4. Equipped for the industrial outreach through the experimental knowledge gained through dissertation work.

- Supervisor would be allocated a research topic to the student at the start of the semester and research.
- Student has to complete the literature review on allocated topic.
- After extensive review of literature students with the help of supervisor has to frame the research objectives.
- At the end of the semester the student has to prepare a ppt presentation as per the university guidelines and present before departmental research committee for finalizing the research objectives.
- Student has to submit the synopsis.

Course Code	**PHY671**
Course Title	**Seminar & Summer Training**
Type of course	Minor
L T P	0 0 4
Credits	2
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	The course would develop soft skills of students, scientific aptitude, critical thinking, research writing and research presentation.
Course Outcomes (CO)	**Students will able:** CO1: To investigate various aspects related to the Physics. CO2: To analyze the literature and its relevance to his/her topic of interest. CO3: To prepare the research design CO4: To make the presentation on a given topic of research.

- The seminar must include discussion on new advancements in different research fields of Physics, Noble laureates in Physics.
- Student will contact the respective mentor/seminar coordinator at allocated schedule to:

l. Conduct the literature survey of the topic allotted.

2. In the next step the student will prepare a detail report in consultation with mentor.

3. The student will learn from the mentor how to prepare presentations.

4. The student will give presentations before the mentor at allotted time schedules regularly.

5. Final seminar of students will presented before the committee consisting of all faculty members of Physics and submit their reports duly signed by mentors on the dates notified to them.

- Students should complete their summer/ Industrial training/Internship during their summer/winter vacations.

(Minimum 30 days & Maximum 45 days) in some other Institutions / Industries/ interdepartmental instrumentation lab like NITs, IITs , CSIR Labs , IOCL, etc and the student will give final presentation of their training before the departmental committee.

SEMESTER IV

Course Code	**RM654**
Course Title	**Advances in Research Methodology in Physical and Mathematical Sciences**
Type of course	Major
L T P	4 1 0
Credits	5
Course prerequisite	B. Sc. Medical or Non-medical
Course Objective	To understand the philosophy of research and ethics, research integrity and publication ethics. To identify research misconduct and predatory publications. To understand indexing and citation databases, open access publications, research metrics (citations, h-index, impact Factor, etc.). To understand the usage of plagiarism tools
Course outcomes (CO)	**Students will able:** CO1: To understand some basic concepts of research and its methodologies. CO 2.To identifies appropriate research topics. CO3.To Select and define appropriate research problem and parameters.

UNIT I

Statistics in Research, Percentages, Frequency distribution, Averages, Measures of central tendency, Arithmetic means, Median, Mode, Geometric Mean, Harmonic Mean, Dispersion, Range, Mean Deviation, Standard Deviation, Root mean square deviation, variance, moments.

UNIT II

Basic Statistical Distributions and their applications: Binomial, Poisson, Normal, Exponential, Weibull and Geometric Distributions.

UNIT III

Sample size determination & sampling techniques: Random sampling, stratified sampling, systematic sampling and cluster sampling. Large Sample Tests and Small Sample Tests: Student t-test, F-test and $\chi 2$ test and their applications in research studies.

UNIT IV

Correlation and Regression Analysis-Time series analysis: Forecasting methods. Principles of Experimentation, Sampling Design - Different Types of Sampling Design - Simple Random Sampling – Stratified Random Sampling - Systematic Sampling - Cluster Sampling - Area Sampling - Multistage Sampling.

Text and Reference books:

S.No.	**Name/Title**	**Author**	**Publisher**
1	Research Methodology: Methods & Techniques (Rev. Ed.)	C.R. Kothari	New Age International. New Delhi
2	Business Research Methods	Alan Bryman & Emma Bell	Oxford University Press
3	Research Methodology	Sinha, S.C. and Dhiman, A.K.	ESS Publications
4	An Introduction to	B.L. Garg, R. Karadia,	RBSA Publishers

	Research Methodology	R., F. Agarwal, F. and U.K. Agarwal	
5	Intellectual property right	Deborah, E. Bouchoux	Cengage Learning

Course Code	**PHY652**
Course Title	**Solar Cells and its Applications**
Type of course	Major(DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	The objective of the course is to study renewable, clean source of electricity and its applications.
Course Outcomes (CO)	**Students will able:** CO1: To measure and evaluate different solar energy technologies through knowledge of the physical function of the semiconductor devices. CO2: To study different types of solar cells. CO3: To understand the basic principle, working and applications of photo electrochemical solar cell and dye sensitized solar cells. CO4: To understand the polymer, nanostructure involved in fabrication of solar cells.

UNIT-I

Basic of Semiconductor Physics: p-n junction, charge carriers in semiconductors, optical properties of semiconductors, Hetero- junctions.

Solar radiation outside the Earth's Atmosphere, Solar radiation at the earth's surface Instrument for measuring the solar radiation and sunshine, solar radiation data, solar radiation Geometry, solar radiation at tilted surfaces,

Solar energy fundamentals: nature of solar energy, conversion of solar energy, photochemical conversion of solar energy, photovoltaic conversion, photophysics of semiconductors and semiconductor particles, photocatalysis.

UNIT-II

Types of solar cells: P-N junction solar cells, current density, open circuit voltage and short circuit current,

Device physics of silicon solar cells: Semiconductor device equations, The p-n junction model of Shockley, Real diode characteristics,

Description and principle of working of crystalline silicon solar cells: Silicon cell development, Substrate production, cell processing, cell cost, Opportunities for improvement, polycrystalline and amorphous silicon solar cells, conversion efficiency, Elementary ideas of Tandem solar cells Manufacturing costs, Environmental issues, Challenges for the future.

UNIT-III

Photoelectrochemical solar cell: Semiconductor electrolyte interface, Basic principle and working of Graetzel Cell i.e., dye sensitized solar cells (DSSCs), Derivation of the Lifetime in DSSCs, factors affecting on efficiency of DSSCs, present DSSCs research and developments, limitations of DSSCs.

UNIT-IV

Introduction to conducting polymers, basic principle of HOMO & LUMO, bulk heterojunction polymer: solar cell Basic working principles, device architectures, single layer, Bilayer, Bulk heterojunction, diffuse bilayer heterojunction, tandem solar cell, efficiency relationship in organic bulk heterojunction solar cells. Quantisation effects in semiconductor nanostructures, optical spectroscopy of quantum wells, superlattices and quantum dots, Basic principle and working of quantum dot sensitized solar cells, effect of device architecture, theory of electron and light dynamic in QDSSCs.

Text and Reference Books:

S. No	**Name**	**Author(S)**	**Publisher**
1	Physics of Solar cell from principle to new concepts	Peter Wurfel	Wiley
2	Photolelectrochemical solar cell	Suresh Chandra	Chemical Communications
3	Solar energy conversion	A.E. Dixon and J.D. Leslie	Elsevier
4	Solar cells	Martin A. Green	University of New South Wales (1986)
5	Solid state electronic devices	B.G. Streetman	Pearson
6	Dye sensitized solar cell	Michael Graetzel	Review article

Course Code	**PHY654**
Course Title	**Polymer & Liquid Crystal**
Type of course	Major(DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	The objective of the course is to study polymers and liquid crystals and its applications.
Course Outcomes (CO)	**Students will able:** CO1: Identify different concepts of polymers and liquid crystals. CO2:Describe problems related to preparation, classification and characterization of polymers and optical crystals CO3: Apply principles to determine the basic properties of polymers and liquid crystals.

UNIT-I

Polymer: Introduction, monomer, degree of polymerizations, chemistry of polymers, polymer synthesis and polymer structure, polymers classification's, polymer morphology, thermal properties, multi component polymeric materials, applications.

UNIT-II

Liquid Crystals, Classification of liquid crystals: Thermotropic and lyotropic, Nematic, Smectic, cholestric, Ferroelectric liquid crystals (LCs), Blue phase LCs, molecular structure of LCs, structureproperty relationship of thermotropic liquid crystals. Molecular and mean field theory, Birefringence phenomena, polarizing microscopy, texture identifications and defects, Electric & Magnetic effects, Optical properties of liquid crystals.

UNIT-III

Liquid crystal composites: polymer and nano-materials dispersed liquid crystal composites, polymer liquid crystals, molecular dynamics between LCs and Dopants.

UNIT-IV

Liquid crystal applications: present and future displays, manufacturing of LCDs, twisted nematic, super-twisted nematic, LED, IPS based displays and overview of LC in advance field's.

Text and Reference Books:

S. No	**Name**	**Author(S)**	**Publisher**
1	Introduction to Liquid crystal Chemistry and Physics	Peter J. Cooling and M. Hird	Taylor and Francis
2	The Physics of Liquid Crystals	P.G. De. Gennes	Oxford University Press
3	Liquid Crystals	S. Chandrasekhar	Cambridge University Press
4	Handbook of Polymer Science and Technology	by M. H. Ferry	CBS, Vol. 2
5	Polymer Science	Gowarikar	Johan wiley and Sons

Course Code	**PHY656**
Course Title	**Thin Film Technology**
Type of course	Major(DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	The objective of the course is to enable the students to understand various methods of film deposition and their advantages and disadvantages
Course Outcomes (CO)	**Students will able:** CO1: Identify different concepts of film deposition. CO2: Describe problems related to deposition of thin films and their growth CO3: Apply principles to determine the effect of different techniques of film deposition and growth

UNIT-I

Thermal evaporation techniques of film deposition: Hertz Knudsen equation; mass evaporation rate; Knudsen cell, Directional distribution of evaporating species Evaporation of elements, compounds, alloys, Raoult's law; electron beam evaporation, pulsed laser deposition, ion beam evaporation, glow discharge.

UNIT-II

Sputtering techniques of film deposition: dc and rf sputtering, Bias sputtering, magnetically enhanced sputtering systems, reactive sputtering, Sol-Gel synthesis, drop casting, spin coating and LB techniques.

UNIT-III

Physical Vapour deposition, Chemical Vapor Deposition: reaction chemistry and thermodynamics of CVD; Thermal CVD, laser & plasma enhanced CVD, Chemical Techniques: Spray Pyrolysis, Electrodeposition, Ion plating, reactive evaporation, ion beam assisted deposition.

UNIT-IV

Nucleation & Growth in thin films: models of nucleation, basic modes of thin film growth, stages of film growth. & mechanisms, amorphous thin films, Epitaxy - homo, hetero and coherent epilayers, lattice misfit and imperfections, epitaxy of compound semiconductors. Properties and technological applications of thin film.

Text and Reference Books:

S. No	**Name**	**Author(S)**	**Publisher**
1	The Materials Science of Thin Films	Milton Ohring	Academic Press Sanden
2	Thin Film Phenomena	Kasturi L. Chopra	Mc Graw Hill (NewYork)
3	Thin – Film Deproperities; Principles and practices	Denald L. Smith	Mc. Grow Hill, Inc
4	Thin Film Fundamentals	Goswami A	New Age International Publishers. New Delhi

Course Code	**PHY658**
Course Title	**Non-linear Fiber Optics**
Type of course	Major(DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	The objective of the course to equip the students with knowledge of basics of nonlinear optics, various nonlinear phenomena, multiphoton processes, nonlinear optical materials and fiber optics.
Course Outcomes (CO)	**Students will able:** CO1: To explain the wave propagation an anistropic crystal and polarization response of materials to light. CO2: To understand the theory and experiments involved in optics. CO3: To explain the use of organic and inorganic materials, X- ray diffraction, FTIR,FT-NMR. CO4: To explain importance of optical fibre.

UNIT-I

Introduction: frequency dependent and intensity dependent refractive index, Wave propagation in an anisotropic crystal, Polarization response of materials to light, Second harmonic generation, Sum and difference frequency generation, Phase matching, four wave mixing, Third harmonic generation, Self focusing, Parametric amplification, Bistability.

UNIT-II

Two photon process: Theory and experiment, Three photon process parametric generation of light, Oscillator, Amplifier, Stimulated Raman scattering, Intensity dependent refractive index optical Kerr effect, photorefractive, electron optic effects.

UNIT-III

Basic requirements: Inorganics, Borates, Organics, Urea, Nitro aniline, Semi organics, Thio urea complex, X-ray diffraction, FTIR and FT-NMR qualitative study, Kurtz test, Laser induced surface damage threshold.

UNIT-IV

Introduction to Optical fibers: Principle, Structure of Optical fibers, Acceptance angle and cone, Numerical aperture and acceptance angle, Fiber modes, Types of optical fibers, Fiber bandwidth, Fabrication of optical fibers, Loss in optical fibers, Fiber optical communication, splicing, Light source for optical fiber, Photo-detectors, Fiber optical sensors and its classification, Fiber endoscope, Attenuation coefficient – Material absorption.

Text and Reference Books:

S. No	**Book Name**	**Author(S)**	**Publisher**
1	Non Linear Optics	Robert W. Boyd	Academic Press New York
2	The principles of nonlinear optics	Y.R. Shen	John Wiley, New York,1984
3	Lasers and nonlinear optics	B.B. Laud	New age international (p) ltd.

4	Fiber-optics communication system	Govind P. Aggarwal	John Wiley& Sons

Course Code	**PHY660**
Course Title	**Physics of Low Dimensional Semiconductors**
Type of course	Major(DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	The objective of the course is to enable the students to understand various concepts of Physics of Low Dimensional Semiconductors
Course Outcomes (CO)	**Students will able:** CO1: Identify different concepts of heterostructures. CO2: Understand solution of Schrodinger wave equation in one dimensional well. CO3: Understand the concept of quantum well.

UNIT-I

General properties of heterostructures, Growth of heterostuctures: MBE & MOCVD, Band Engineering, Band Diagrams of different heterostructures, Superlattice devices, Doped Heterostuctures: Modulation Doping, band diagram of modulation doped layer, MODFET, electrostatic potential, conduction band and gate bias, threshold voltage, gate-channel capacitance, screening by 2D electron gas, layered structures, band structure modifications by strain, Quantum wires and dots.

UNIT-II

Solution of Schrodinger wave equation in one dimensional: square wells of finite and infinite. depths, parabolic and triangular wells, Low dimensional systems, sub-bands and their occupation, Two and three dimensional quantum wells: cylindrical, two dimensional parabolic and spherical wells, Quantum wells in heterostructures, Tunneling transport in semiconductors, potential step, square barrier, T -matrices, Tunneling current in one, two and three dimensions, Resonant Tunneling through Quantum Wells, Coulomb Blockade and single electron devices, Tunneling in Heterostructures, Intervalley transfer.

UNIT-III

Semiclassical dynamics : Semiclassical dynamics of electrons in a magnetic field, semiclassical approach to magenetotransport, Quantum mechanical approach to electrons in uniform magnetic fields, Landau levels, Aharonov-Bohm effect, De-Haas effect, Shubnikov-de-Haas Effect, Quantum Hall Effect, Fractional Quantum Hall Effect.

UNIT-IV

General Theory of optical properties of Quantum Wells: Kramers-Kronig relations, optical -response functions, sum rules, valence band structure: Kane model, energy bands in a quantum well, interband Transitions in quantum wells, Absorption spectrum, optical gain and lasers, Excitons in two and three dimensions, Excitons in a quantum well.

Text and Reference Books:

S. No	Name	Author(S)	Publisher
1	Physics of Low Dimensional Semiconductors	- John H Davies –-	Cambridge University Press -1998.
2	Low Dimensional Semiconductor Heterostructures	- Keith Barnham & Dimitri Vvedensley	– Cambridge University Press
3	Physics of Semiconductors and their Heterostructures -	Jasprit Singh	– Mc Graw Hill -1994

Course Code	**PHY662**
Course Title	**Geophysics**
Type of course	Major(DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	To locate or detect the presence of subsurface structures or bodies and determine their configuration (i e size determine their configuration (i.e. size, shape, depth) and physical properties (i.e. physical parameters).
Course Outcomes (CO)	**Students will able:** CO1: To study the overview of the structure and evolution of the Earth as a dynamic planet within our solar system. CO2: To study the Geodynamics and Geochronology of earth surface. CO3: To understand the radioactivity & radioactive contents in different rocks. CO4: To describe different nuclear techniques involved to detect rock density, concentration of radioactive elements in rock.

UNIT-I

Seismology and Interior of the Earth: Origin of earth, shape, size, mass and density of the earth. Theory of seismic waves. The variation of P and S wave velocity, temperature, density, pressure and elastic parameters with depth. Mineralogical and chemical composition of crust, mental and core. Formation of core. Earthquake; effects, types, mechanism, source parameter, and hazard assessment.

UNIT-II

Geochronology and Geodynamics: Geological Time Scale, Radioactive dating methods (U-Pb, Th-Pb, Pb-Pb, Rb-Sr, K-Ar, and C-14), Fission Track dating, Interpretation and discordant ages, age of earth,

Heat flow: thermal and mechanical structure of the continental and oceanic lithosphere.

Plate tectonics theory: kinematics, dynamics and evolution of plates; types of boundaries, processes. Geodynamics of Indian plate.

UNIT-III

Radioactivity of Rocks: Magnetic differentiation, Browns reaction series, Radioactivity of rocks, soil, water and air, Uranium mineralization and its occurrences in India,

Radiometric survey of rocks: ground and air borne surveys, Radiometer and emanometer, Role of radiometry in geophysical prospecting, gamma logging and gamma testing.

UNIT-IV

Nuclear Techniques: Gamma-transmission method for determination of rock densities in Laboratory and in-situ. Gamma spectrometric analysis for U, Th and K in rock/soil.

Neutron activation analysis: Equation for buildup of induced activity.

Text and Reference Books:

S. No	**Name**	**Author(S)**	**Publisher**
1	The Solid Earth	C.M.R. Fowler	Cambridge University Press
2	Interior of the earth	M.H.P. Bott	Edward Arnold, London, 1982
3	The Earth's age and Geochronology	D.York and R.M. Fraquhar	Cambridge University Press

Course Code	**PHY664**
Course Title	**Non-Linear Dynamics**
Type of course	Major(DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	This course is designed to provide an advanced level learning of Nonlinear Dynamics, Chaos and applications.
Course Outcomes (CO)	**Students will able:** CO1: To discuss on the linear stability analysis and the Illustration of basic bifurcations with suitable examples. CO2: To give a detailed account of the stability of fixed points and the period doubling route to chaos in logistic map CO3: To understand application of inverse scattering transform techniques: Solution to Korteweg-de-Vries (KdV) equations.

UNIT-I

Dynamical Systems Linear and nonlinear differential equations: Autonomous and non autonomous systems - Phase trajectories, phase-space, flows and limit sets – Classification of equilibrium points in planar systems – Invariant manifolds - stable, unstable and center manifolds - Periodic orbits, limit cycles, Poincaré maps and Floquet theory - Poincaré-Bendixson theorem – Exercises and problems.

UNIT-II

Bifurcations and Chaos Bifurcation theory: Local and global bifurcations - Three dimensional autonomous systems and chaos, Lyapunov exponents -– Torus – quasi-periodic attractor – Poincaré map – Period doubling cascades – Feigenbaum number – characterization – Homoclinic orbits, heteroclinic orbits – Strange attractor and strange non-chaotic attractor – Exercises and problems.

UNIT-III

Discrete Dynamics Systems, Synchronization and Controlling of Chaos Linear and nonlinear discrete dynamics systems: complex iterated maps – Logistic map – Linear stability – Period doubling phenomena and chaos – Lyapunov exponents – Chaos synchronization – Synchronization manifold and stability properties – Controlling of Chaos – applications, Dimension of regular and chaotic attractors – Fractals – Koch curve – Cantor set – Sierpinski set – Julia and Mandelbrot sets – Cellular automata – Self organized criticality – Stochastic resonance – pattern formation – Time series analysis.

UNIT-IV

Integrable Systems and Solitons Finite dimensional integrable systems: Linear and nonlinear dispersive systems – Cnoidal and solitary waves - The Scott Russel phenomenon and derivation of Korteweg-de Vries (KdV) equation – Fermi – Pasta – Ulam (FPU) numerical problem – FPU recurrence phenomenon – Numerical experiments of Zabusky and Kruskal – Explicit soliton solutions: one-, two- and N-soliton solutions of KdV equation – Hirota's bilinear method

Text and Reference Books:

S. No	Name	Author(S)	Publisher
1	Nonlinear Dynamics: Integrability Chaos and Patterns	M. Lakshmanan and S. Rajasekar	Springer-Verlag, Berlin, 2003
2	Chaos in Nonlinear Oscillators	M. Lakshmanan and K. Murali	World Scientific, Singapore, 1996),
3	Nonlinear Dynamics in Complex Systems: Theory and Applications for the Life- , Neuro- and Natural Sciences	A. Fuchs	Springer, 2013
4	Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering	S. H. Strogatz,	II Edition (CRC Press, 2014)
5	Complex Dynamics and Morphogenesis: An Introduction to Nonlinear Science	C. Misbah	Springer, 2017
6	Deterministic Chaos: An Introduction	H. G. Schuster,	Wiley-VCH, 2005

Course Code	**PHY666**
Course Title	**Introduction to Astrophysics**
Type of course	Major(DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	To locate or detect the presence of subsurface structures or bodies and determine their configuration (i e size determine their configuration (i.e. size, shape, depth) and physical properties (i.e. physical parameters).
Course Outcomes (CO)	**Students will able:** CO1: Identify different concepts to develop solar physics applications. CO2: Describe problems related to solar and astrophysics CO3: Apply principles to describe solar and astrophysics

UNIT-I

Structure of the Sun: Solar interior, solar atmosphere, photosphere, chromosphere, corona; Small & large scale Solar structures, Sun spots and their properties, Prominences, Solar Flare: classifications, phases & flare theory; Solar cycle, Solar magnetic field. Observed and derived properties of solar wind.

UNIT-II

Solar wind formation: Fluid theory for static as well as expanding isothermal solar atmosphere, Spatial configuration of magnetic field frozen into the solar wind, Termination of solar wind, Heliosphere.

UNIT-III

Qualitative description of Astro-objects (from planets to large scale structures): length, mass and time scales, Evolution of structures in the universe; Red shift, Expansion of the universe. Simple orbits, Kepler's laws, Flat rotation curve of galaxies and implications for dark matter.

UNIT-IV

Role of gravity in different astrophysical systems; Radiative Process: Radiation theory and Larmor formula, Different radiative processes.Star formation, Stellar evolution, Supernovae, H-T diagram, Compact Stars. Milky way galaxy, Spiral and elliptical galaxies, Active galaxy, Black holes.

Text and Reference Books:

S. No	Name	Author(S)	Publisher
1	Astrophysics of the Sun	Harold Zirin	Cambridge University Press
2	Solar System Astrophysics	J. C. Brandt & P.W. Hadge	Cambridge University Press
3	Guide to the Sun	Kenneth J. H. Philips	Cambridge University Press
4	Astrophysical Concepts	M. Harwitt	Springer-Verlag, New York
5	An Introduction to Modern Astrophysics	W. Carroll & D. A. Ostlie	Pearson
6	The Physics of Astrophysics Vol I & II	Frank H. Shu	University Scien

Course Code	**PHY668**
Course Title	**Dissertation- II**
Type of course	Major
L T P	0 0 16
Credits	8
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	The dissertation would develop scientific aptitude, reviewing of literature, critical thinking, hypothesis development, experiment planning, synopsis writing, problem presentation and way to solve the problem.
Course Outcomes (CO)	**Students will able to:** CO1: Explore research aptitude & practical ability of knowledge gained by student in understanding the basics of research CO 2. Develop critical thinking through the detailed review of literature comprehend expertise for writing the research reports in form of review article as well as research publications. CO3. Analyze & generate experimental skills towards the industrial applications. CO4. Equipped for the industrial outreach through the experimental knowledge gained through dissertation work.

- Student has to complete their experimental/theoretical research work and complied it.
- At the end of the semester the student has to prepare a Dissertation as per the university guidelines.
- Upon submission of the Dissertation, the student would be evaluated by Institutional RDC based on a ppt presentation.

Course Code	**RM656**
Course Title	**Scientific and Technical Writing**
Type of course	Minor
L T P	0 0 4
Credits	2
Course prerequisite	B.Sc. with physics as one of major subjects
Course Objective	This course will help you write well-researched, organized, and correctly documented research papers.
Course Outcomes (CO)	**Students will able:** CO1: To find research resources, such as online resources (research databases, reference lists), and campus resources (writing centers, research librarian help) CO2: To evaluate the credibility of research sources, especially the online resources CO 3:To find reference articles including scholarly articles from journals and news articles from foreign and domestic news sources CO4: To learn strategies to avoid plagiarism and academic dishonesty such as using APA/MLA citation styles preparing a bibliography (references list), etc.

UNIT-I

Introduction to Technical Writing: what is research? , how do you structure a research paper? Basic Principles in Technical Writing: (Audience, Purpose, Organization, Flow, Style, Presentation)

UNIT-II

Introduction to text analysis tools: analyzing research paper biographies, Writing a research paper abstract: choosing between indicative and informative abstracts writing a research paper title: keywords, noun phrases, and prepositions.

UNIT-III

Writing a research paper introduction: characteristic features and structure of introductions, explaining the situation, describing problems/limitations, describing the response.

UNIT-IV

Writing a research paper results section: deciding the type of visual aid, explaining figures and tables, writing a research paper discussion/conclusion section: summarizing results, adjusting the strength of interpretations using hedging.

S. No	**Name**	**Author(S)**	**Publisher**
1	Thesis and assignment writing	Anderson B.H., Dursaton, and Poole	M.: Wiley Eastern 1997
2	Research Design and Methods	Bordens K.S. and Abbott B	Mc Graw Hill, 2008
3	The Student's Guide to Research Ethics	Paul Oliver	Open University Press, 2003

4	Research Methods – A Process of Inquiry	Graziano, A., M., and Raulin, M.,L	Sixth Edition, Pearson, 2007